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ILLINOIS BIOLOGICAL MONOGRAPHS

PUBLISHED QUARTERLY
UNDER THE AUSPICES OF THE GRADUATE SCHOOL
BY THE UNIVERSITY OF ILLINOIS

VOLUME II

Urbana, Illinois
1915-16

7886

Editorial Committee

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(Distributed June 30, 1916)

ILLINOIS BIOLOGICAL MONOGRAPHS

Vol. II July, 1915 No. 1

EDITORIAL COMMITTEE

STEPHEN ALFRED FORBES WILLIAM TRELEASE
HENRY BALDWIN WARD

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THE UNIVERSITY OF ILLINOIS

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Distributed October 5, 1915.

THE CLASSIFICATION OF LEPIDOPTEROUS LARVAE

WITH TEN PLATES

BY

STANLEY BLACK FRACKER

Contributions from the
Entomological Laboratories of the Universitity of Illinois
No. 43.

THESIS

Submitted in Partial Fulfilment of the Requirements
for the Degree of Doctor of Philosophy in
Entomology in the Graduate School
of the University of Illinois
1914

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ACKNOWLEDGMENTS

The subject of this paper was suggested by Professor Alexander D. MacGillivray in the fall of 1912. During the two years since that time the writer has become more and more convinced of the necessity for and value of taxonomic studies of immature insects. While a classification based on larvae would doubtless include as serious mistakes as one in which only the adults were considered, combining the two methods results in the elimination of a great many errors. In addition to this purely scientific ideal, the demand of students and economic entomologists for some means of identifying larvae without rearing them has acted as an even stronger incentive to persistent effort.

The author wishes to express his sincere appreciation of the suggestions and criticisms of Professor MacGillivray throughout the preparation of the paper and of the inspiration which has come from association with him. The authorities of the University of Illinois have, through liberal appropriation, made possible the purchase of material from Dr. O. Staudinger and A. Bang-Haas of Dresden, from the Kny-Scheerer Company, from the Ward Natural Science Establishment, and from Mr. Wm. Beutenmüller. They have also enabled the writer to study for several months at the United States National Museum, where the series of lepidopterous larvae is probably the most extensive in the world. For securing this assistance, for continuous encouragement, and for placing at his disposal the material of the Illinois State Laboratory of Natural History, the author gives hearty thanks to Professor Stephen A. Forbes. Grateful acknowledgments are due Dr. L. O. Howard for his courtesy in granting use of the entomological collections of the National Museum. To Dr. Harrison G. Dyar, Mr. August Busck, and Mr. Carl Heinrich, the writer is indebted for numerous suggestions and for making these collections accessible and helpful.

PART ONE. THE HOMOLOGY OF THE SETAE

I. Introduction

One of the most serious difficulties in the path of scientific progress is the lack of a means of expression common to all the workers in a single field. When a particular term means one thing to one scientist and something else to another, no amount of learning will make the opinions of these men intelligible to each other until they understand the difference. In human anatomy, the large number of workers, the excellent figures, and the antiquity and narrow limits of the subject have to a large extent removed this confusion but in other fields of biology the mistakes it causes are still apparent. This is true in entomology and very noticeably so in the study of larvae.

The various systems of numerals which have been applied to the setal arrangement of lepidopterous larvae are all based on the simple plan of numbering the setae from the dorsomeson. Except in the most conspicuous cases, little consideration is taken of the relations of the different segments to each other. Several authors have already introduced confusion by applying the numbers in a slightly different way from that first suggested, but no careful investigation has been made of the real relations of the larval chaetotaxy of one group to that of another.

Realizing the conflicts in the application of the numerals now in use and the nature of the objections to them, the writer began the study of caterpillars with an investigation of the homology and homotypy of the setae. The object of the former was a determination of the changes which have taken place in the ancestral history of any particular body segment, such as the prothorax, and the application of a given name to the same structure throughout the entire order. The study of the latter, homotypy, was taken up for the purpose of finding the relation of the setal pattern of the different body segments to each other, in the hope of applying the same name to the same structure throughout the entire body. All the segments behind, but not including, the head were studied and satisfactory results were obtained for all except the tenth or last abdominal segment.

It is intended that the figures, descriptions, and definitions shall make every statement in this paper absolutely definite and that they shall be so clear that a novice may be able to make a complete description of a caterpillar without the possibility of confusion as to his meaning. New species and new instars should be described in a manner which will make like specimens recognizable in the future without repeating the breeding. Such complete descriptions in the published records are very few at the present time.

HISTORICAL

The first worker to find and describe a primary plan of the setae of caterpillars was Wilhelm Müller (1886), in a paper on the Nymphalidae. After discussing the arrangement in the first stage of these butterfly larvae, he says: "We find in the first stage, on the abdomen of all forms considered, certain setae. Tho of many different forms their constant arrangement shows them to be homologous. We call these setae primary. * * Doubt as to the similarity between the mesothorax and metathorax and the abdomen seems to be out of the question." In an appendix, brief notes on the chaetotaxy of the larvae of other families of Lepidoptera are given. Careful comparison is made between the Saturnioidea and the Sphingidae.

Dr. Harrison G. Dyar did not find this paper and in 1894 again discussed the subject as new and numbered the primary setae. So far as I know, this author makes the first suggestion that the position of the setae be used in classification. His observations included a few representatives of many families and his phylogeny as based on them is remarkably good. He also numbers the metathoracic setae but makes no attempt to show that the seta bearing a certain number on the abdomen is homologous with one bearing the same number on the thorax. He himself realized that the metathoracic "tubercles," i a+i b and ii a+ii b (Fig. 11), were not the homotypes of the abdominal setae i and ii (Fig. 12), and in 1901 made a definite statement to that effect. This discussion, therefore, can not be considered a contribution to the study of homotypy.

In another paper the following year the same author reported observations on the first stages of many larvae, finding that they differed considerably from following stages. By these observations he established the primary arrangement of the setae on the abdomen and demonstrated its uniformity throughout a great part of the order. A few months later, in "A Classification of Lepidoptera on Larval Characters'', he made the former work on the Frenatae apply to the setal pattern of the Jugatae. The purpose of this paper was, however, more to point out the differences between the larvae of the two suborders than to show their similarity.

O. Hofmann (1898) described the first and later instars of certain pterophorid larvae, reaching the conclusion that the thoracic and abdominal setae are homologous but that additional ones are present on the prothorax. The suggestions he makes and the reasons given are excellent. Dyar's nomenclature is used, with the result that he does not make his own conceptions as clear as if he had changed it to meet his own ideas of homology.

In response to criticism by Hofmann, Dyar (1901) finally did express an opinion on the serial homology of the setae so far as the last two thoracic and first eight abdominal segments are concerned. The table he gives, which is as follows, merely indicates his agreement with the views of Hofmann.

Numerals now applied		Should be called
Thorax II and III	Abdomen 1 to 8	
i a	i	i
i b	ii	ii
ii a	iii	iii
ii b	iv	iv
iii	—	v a
iv	v	v
v	vi	v b
vi	vii	vi

It will be seen that the conclusions indicated by the table agree in most particulars with those reached on later pages of this paper except in the relation of setae iv and v. Altho the point will be discussed later, it should be mentioned here that the error arises from a failure to consider the condition in Hepialus. The larvae of that genus show clearly that the missing seta near the abdominal spiracle is not between iv and v but above iv. Seta iv of the metathorax is therefore homotypic with iv of the abdomen, v with v of the abdomen, and vi of the abdomen is not represented on the thorax. Other reasons for this view will be discussed later.

Ambrose Quail (1904) discusses these particular setae, basing his opinions on the condition in the first instar of certain Hepialidae and Frenatae. He calls attention to the error mentioned above and shows Dyar's mistake concerning the true meaning of ii b. Instead of being homotypic with iv of the abdomen, it is shown to be really iii a, a seta which Dyar had either overlooked or considered of no importance.

W. T. M. Forbes' work (1910) did not cover the subject of the homotypy of the setae. The few figures he labels include errors for which he was not responsible as he had not given the subject consideration. (See discussion of theta, page 34.)

Siltala (1907) made a study of the chitinous armature, especially the setae, of caddice-worms. He finds considerable variation in the order (Trichoptera) but carefully compares the different arrangements. The setae of the first larval stage are very sparse while those of later instars are obviously special and secondary developments. In neither case can satisfactory comparisons be made with the Lepidoptera.

THE CHAETOTAXY OF A TYPICAL SEGMENT

While previous workers have drawn so-called type segments, these have never included all the setae found in larvae of this order. Their significance has been limited to particular segments or to particular groups. For example, Dyar's ''typical segment'' refers to the abdomen only, altho it has been extended to cover the last two thoracic segments of the larvae of Frenatae.

In order to make the following pages clear, attention should be called at this point to the diagram (Fig. 1) which shows all the primary and subprimary setae normally present on the segments of any generalized lepidopterous larva. The evidence on which this diagram is based and also the reasons for the adoption of Greek letters instead of numerals in naming the setae are given on later pages. This hypothetical type is mentioned here as a point of reference in order that it may be possible to use the setae as illustrations of the general principles on which this study of homology is based. On the same and the following plates are shown some of the modifications of the plan.

It has been necessary to introduce certain new terms in this paper and in a few cases to use the old terms in a special sense. A glossary will be found at the close of Part Two, giving the meaning of all words used in a special sense in this discussion. The explanation of plates (p. 147) gives the names and grouping of all the setae.

II. Nature of the Evidence

It is necessary first to outline the principles underlying attempts at any determination of homotypes. The evidence on which decisions in doubtful cases were based is discussed here, for some of the principles are not axiomatic. Their correctness will not be disputed, I am sure, by those who consider the broad basis of fact on which they rest.

DEFINITIONS

According to the Standard Dictionary, homology refers either *(a)* to ''the correspondence of a part of one animal with another, determined by agreement in derivation and development from a like primitive origin,'' or *(b)* to homotypy, which is ''the correspondence of a part or organ of one region with that of another region in the same animal.'' Smith, in the ''Glossary of Entomology'', adds the usual provision that ''the organs must be identical in general structure and origin, tho they may have developed in different ways for different purposes.''

There is an important difference between the homology of crustacean appendages with each other and the homology of the setae in insects. In the former case, work is based on similarity in the fundamental structure and development of the homologous organs; in the latter, only position can be considered, as the setae are all similar in structure. For that reason it is necessary to secure a little more accurate definition as a basis of work. With this in view, I suggest the following:

Two organs on different segments of the same animal are homotypic, regardless of their positions at the present time, when they have developed from homotypic organs of a generalized ancestor. In a generalized type, two similar organs on different segments are homotypes when they bear the same relations to the other organs of their respective segments.

To show that a prothoracic seta, for example, is homologous with one on the mesothorax, it is necessary to show that at one time the anlagen from which these setae were developed were in similiar positions on their respective segments. On the other hand it is equally true that, when two setae of a specialized form are in similar positions on their respective segments, a demonstration that they diverge farther and farther as we study the more and more generalized types shows that they are not true homologues but have converged in phylogenetic development. This gives to ancestry the primary importance and makes necessary a consideration of the nature of the evidence which bears on phylogeny.

DIFFICULTIES

The meagerness of the results thus far obtained on this problem is due partially to peculiar difficulties in its solution. Certain obstacles stand in the way of an accurate and complete demonstration of the homology of the setae. They are mentioned, not to emphasize the magnitude of the task, but to explain the fact that so many doubtful points remain unsettled.

The first of these difficulties is caused by the absence of intermediate stages between radically different conditions. When the tubercles* have been modified to form scoli or verrucae, it often seems impossible to determine whether differences have arisen by coalescence or by the disappearance of some of the tubercles. In many cases this is a very real problem, on whose solution depends the correctness of the conception of large groups.

Another obstacle is the lack of developmental series. In the case of wings, the tracheae which precede the veins in larval and pupal stages plainly show the relation of the adult venation to the generalized type. The single elementary instar which acts as a guide in the study of the chaetotaxy of caterpillars, however, is sometimes so unlike the mature larva in the arrangement of its setae, that it is of little assistance in interpreting their homology. The change is usually sudden and occurs at molting. Were the recapitulation more often extended over several molts the problem would be easier.

The third difficulty is one that, up to this time, has prevented progress in this field. Apparently a lepidopterous larva has three or more entirely distinct types of arrangement of the setae (Figs. 7, 8). In only a few species is there any apparent relation between the plan of the prothorax and that of the mesothorax, or between the last abdominal segment and any of the others. While this obstacle is not a serious one in classification, it has prevented thus far the determination of a satisfactory nomenclature and therefore of a working basis. Since Wilhelm Müller said in 1886 that he found ''no support for a comparison of the prothoracic setae with those of the following segments'', workers seem to have left the prothorax severely alone. They seem not to have realized that there is evidence not found in the Nymphalidae on which Müller was working.

Fortunately there are partial hints and clews to assist in surmounting each of these obstacles. Study of varied forms often yields signs of intermediate stages in position. Sometimes the single first stage, our only evidence of the past, unmistakably points the way to an interpretation we would not otherwise think of making. Again, the presence of a single unusual seta on a single segment of a generalized form will unite the setal plans of otherwise seriously differing segments. In these ways the gaps are at least partially closed and the problem is taken out of the realm of guesswork and abstraction.

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*The word, "tubercle", is used in this paper as a general term to indicate the location of a seta, or of a definite group of setae, or a process of the body wall bearing such a group.

COMPARATIVE ANATOMY

Caterpillars may be said to bear setae in all possible positions. Their great number and uniform distribution in some species makes naming and homologizing them seem impossible. A little study of the less ''hairy'' ones, however, soon shows that the arrangement is quite constant and further investigation proves that they have all been derived from the same typical plan.

The method used in determining this plan was the ordinary one in problems of this kind. The setae of the prothorax, metathorax, and abdomen of the generalized members of both suborders of Lepidoptera were plotted, one segment over the other, as if all were on the same segment. It was then found that the number of setae in this composite picture (Fig. 1) was about fifteen, and that they were in approximately the same position as on the prothorax of the most generalized forms of the order.

The next problem concerns the relation of the different segments of a larva to each other and to the generalized type. It is clear from the first that the prothorax is least modified throughout the series. We can not assume, however, that the setae of the following segments of a caterpillar may be directly homologized with the type by comparing them with the prothorax of the same individual. Differentiation into the three types of arrangement must have occurred long before the suborders of Lepidoptera were differentiated from each other. The first insect with scaly wings and long maxillae probably arose from a larva possessing a different arrangement of the setae on the abdomen from that on the prothorax. It is possible that all of the thoracic segments were similar, but the abdomen was certainly distinct. In view of that fact, one easily sees that complete reliance on any single modern form is likely to lead to error. An abdominal ''type'' must be worked out in the way used to establish a hypothetical generalized type. Then a comparison of the thoracic and abdominal types with the general type will bring us as near as comparative anatomy can, to a correct view of the homology between the prothorax and abdomen.

ONTOGENY

That the embryological development of an animal has an important bearing on the study of its phylogeny has been recognized ever since the ''recapitulation theory'' was first advanced. This theory has not, however, shown the way to a complete solution of the problems of ancestry. The development of members of nearly all animal groups and that of the rarest and most peculiar forms has attracted numerous workers. Many problems still remain unsolved,—for the recapitulation is neither direct nor easy to interpret and is often covered by such a multitude of complications, reversals, and omissions that we are baffled in an attempt at their solution. For this reason, before an argument can be based on ontogeny, it must be shown that the condition discussed is necessarily a recapitulation.

When the larva of a moth hatches from the egg it is somewhat different, in most cases, from the mature caterpillar. The "woolly bear" is as naked as a cutworm and the butterfly larva could be mistaken for a tortricid. Sometimes indications of this peculiar condition remain after the first molt, but usually this glimpse of the past is as evanescent as it is surprising. Let this minute "worm" reach the second instar and nothing remains to show that the arctian was not always "hairy", or that the ancestors of the saturnian did not possess prominent scoli.

The natural supposition that this first stage is a recapitulation of the past has seldom been doubted. Several arguments, or, rather, suggestions, may however be advanced against it, and these must be disproven before this stage is admitted as evidence.

In the first place it may be urged that this stage represents an adaptive condition. While it is true that the thick setae of an arctian or the spiny processes of a nymphalid might prove an obstacle to hatching, this would merely show that the former condition had been retained in the first instar after the appearance of the new armature in later development, rather than that a new elementary stage had been acquired. At the same time such an interpretation can not give us a clue to the reason for the lack of one of the setae (mu) (cf. Figs. 29 and 31) on the abdomen of all the Frenatae in the first stage, and its presence after the first molt. Nor is it clear how the absence of theta from slightly different positions on all the segments of Hepialus (cf. Figs. 2, 3, 4 with Fig. 6) could assist in emerging from the egg. Secondary adaptation might explain a transformation in the entire style of armature but only recapitulation can suggest a reason for changes in the presence and position of a single seta.

Again, the differences between the elementary stages of different forms may be pointed out and the conclusion reached that they can not therefore represent an ancestral condition. While the first stages are not, it is true, identical throughout the order, they do not vary one-tenth as much as the mature larvae. These first instars diverge slightly in several directions from the ancestral type, while the mature larvae diverge rapidly and extensively from the type. The former are so nearly uniform that their evidence in regard to the past is invaluable.

A third position might be taken with regard to development by successive molts on the supposition that it might not constitute an ontogeny in the usual meaning of the term. At the same time it must be recognized that the instars through which a caterpillar passes are as necessary a part of its development as are the changes within the egg. Specific evidence of recapitulation in the life history of animals which molt is taken up in a later paragraph.

Constructive evidence on the recapitulation theory as applied to larval instars is considerable in amount. Some of it has been suggested in answering the objections and merely the outline of this evidence is given below. There is no need to develop the different points.

I. The instars of other Arthropoda recapitulate their ancestral history. Examples: Sacculina and its degeneration; the changes of barnacles; the zooea, mysis stages, etc., of Decapoda.

II. The phylogeny of other insects is shown by their postembryonic development. Examples: in Coccidae, the presence of the anal ring in the nymphs of Kermesinae, and the appearance of primary and secondary pygidia in certain Diaspinae; in Coleoptera, the campodeiform larva preceding the eruciform in certain cases.

III. The development of the setal plan of lepidopterous larvae itself bears prima facie evidence that it constitutes a recapitulation. 1. All the Frenatae are almost identical in the first instar when that stage is different from later ones. 2. The first stage of the Jugatae is much nearer that of the Frenatae than later stages are. 3. Larvae with tufted setae, as arctians, usually possess only the primary setae before the first molt and these are in the typical position. 4. The armature of the larvae of Nymphalidae and certain other butterflies or specialized Lepidoptera is not homologous with that of the moths but is preceded in the first stage by the setae in the typical position. 5. The absence of theta on all the segments of Hepialus and the Frenatae in the first stage, and its presence on all the segments of Hepialus and on the thorax of Frenatae in the next stage, can have no other meaning than that this seta is a later arrival than those which are present from the time of hatching and that it has become established in the Frenatae on the thorax only. 6. Setae are distinct in the first instar of Sphingidae, Dioptidae, and other groups, but are very much reduced or wanting later. At the same time their descent from forms in which the setae are distinct is unquestionable.

The writer has become convinced from many facts of which the preceding are only examples, that the first-stage larva of Lepidoptera represents the ancestral type; that the arrangement of the setae in this instar is essentially the same their ancestors bore in some remote antiquity. While it does not extend back to that distant age when all the segments bore the same setal plan, it furnishes a connecting link between that period and the present day. I have no hesitancy in denominating, as Dyar does, a seta as only ''subprimary'' when it is constantly wanting in the first stage, however invariable may be its presence in the second. For the same reason I can not consider a subprimary seta of a specialized group as homologous with a primary one of a generalized group. Such an homology is entirely inconsistent with the recapitulation theory.

In a word, the arrangement of the setae in the larvae of the Lepidoptera gives us every reason to believe and no cause to deny the hypothesis Weismann expressed in 1876: ''New characters first appear in the last stage of individual development; these move back gradually into the earlier stages and so crowd out the older characters until the latter finally disappear.''

VARIATION

In many cases the presence of secondary or tufted setae is confusing in determining the location of the primary ones. The acquisition of additional scattered setae in one species or genus is a very common occurrence and caution should be used in giving this character as bounding any group. The condition in Drepanidae, Thyatiridae, and Geometridae furnishes good examples.

When several primary setae are united by being surrounded by a chitinized plate they have a tendency to vary in number. This is true of the Pi group on the proleg-bearing segments of the abdomen. Pi itself consisted originally of two primary setae but tau is usually associated with them. In many Noctuidae the three are borne on a chitinized leg plate. In notodontians, arctians, and other groups specialized from the ancestral noctuid type, this plate bears many setae, none of which can be homologized with the primary ones (cf. Figs. 31 and 33).

III. Application of the Evidence

As stated above, two setae on different segments of the same or different larvae are homologous, regardless of their position at the present time, when they have descended from the same or homologous organs of a generalized ancestor. It follows from the definition that no single case of homology can be absolutely proven. No combination of circumstances is sufficient to show, beyond the shadow of a doubt, that two setae on a modern larva are descendants from the same or homologous structures of some extinct ancestor. Nature's directions are, however, sufficiently clear to remove the problems completely from the realm of speculation. Let us consider for a moment the nature and kind of these indications and their use as evidence on a correct nomenclature of the setae.

APPLICATION OF PRINCIPLES

Similar position in all modern forms.—When a group of setae are in similar positions throughout the entire series of mature caterpillars, we may conclude that they are homologous with each other. If further evidence does not point distinctly in some other direction, we can not go back of this stand. Practically every segment of every caterpillar bears one seta near the medioventral line on each side. This the writer calls sigma and it is clear that in these setae we are dealing with truly homologous organs; that on the thoracic and abdominal segments in Hepialus as well as the Frenatae, these ventral setae are homotypes.

Similar position on certain segments of all modern forms. A nearly uniform arrangement of the setae on the prothorax of practically all the members of the order is excellent evidence that this arrangement is ancestral and that it has not arisen through convergent development. On the other hand, such a condition cannot bear on the relations of the segments to one another.

Similar arrangement on all the segments in the most generalized groups. Every structure of Hepialus points to the view that this genus is one of the most generalized of Lepidoptera. While distinctly in a different suborder, it bears much evidence that it is closer to the ancestral type than are most of the Frenatae. When we find in it, therefore, that the relations (Figs. 5, 6, 13, 14) of alpha, beta, and rho, to each other and to the boundaries of the segments, are identical throughout the body, we have reason to believe that they are homologous in spite of their changed position in the Frenatae on the mesothorax and metathorax. It simply remains to derive the condition found on these two segments of Frenatae from that shown by the same two segments of Hepialus, and again we have a complete series of homologues.

Similar position on all the segments of newly hatched larvae. The bearing of the setal arrangement of first-stage larvae was discussed under the subject ''Ontogeny''. Homologizing a seta never present in this stage with another that is present cannot usually be admitted as justifiable. On the abdomen of Hepialus (Figs. 6, 13) there are three setae, theta, kappa, and eta, in a long diagonal row caudad and ventrad of the spiracle. Of these, the upper one is absent from the first stage on all the segments and therefore, according to Weismann's hypothesis, may be assumed to be of more recent origin. It would certainly be incorrect to homologize it with any primary seta of generalized Frenatae.

Series of changes. Ordinarily two setae in the same relative position on their respective segments are considered homologous. Two setae in different positions may be homologous, however, if they have reached these new positions by migrations during phylogeny. In many cases an intermediate location is shown by the first instar, while in others a large number of mature larvae will show a complete series of steps in the migration from the old position to the new one.

CHOICE OF A NOMENCLATURE

At the present time Roman numerals are in more or less general use as a means of denominating the setae of lepidopterous larvae. They were introduced by Dyar and have been retained, largely in their original sense, partly because the great majority of recent papers describing caterpillars have been written by this worker. The wide distribution of his papers and the undoubted accuracy of his observation would lead the present writer to adopt his nomenclature if that were possible. For several reasons, however, it seems that the use of numbers in this connection is no longer desirable.

In the first place the abdomen of Frenatae, upon which the numeral system was based, can not represent the original type. In some particulars it differs radically from the same segments of the Jugatae. Attempts to derive the setal plan of the thoracic segments from this arrangement and to find any evidence for such a derivation have been fruitless. The original type segment, or better, the potential arrangement from which the modern plan has been derived, must have included a greater instead of a smaller number of setae than are at present found on the meso- and metathorax. Many of the thoracic setae are undoubtedly as primary and as ancestral as those on the abdomen, and the same is true of some of the additional setae shown on Hepialus; therefore, if Dyar's numerals are used we should be compelled either to give letters and subnumerals to primary setae simply because they are not present on the abdomen of modern caterpillars, or to adopt his scheme for the abdomen of Frenatae and apply a different one to all other body-segments and to the Jugatae. Neither of these methods would fulfill our hope of a uniform nomenclature based on homology and applicable to all the segments of all lepidopterous larvae.

In the second place any series of names which have as definite an order as numbers is sure to be misleading and is likely to prejudice one's views in regard to homology. The mere use of numerals beginning at the mediodorsal line tends to cause one to give the upper of two setae the smaller numeral and to neglect the fact that some setae are absent. In wing venation, it is found that when numbers are used, workers tend to neglect studying out the true homology. This danger is still more apparent in work on the setae, for whereas it is rare to find a branch of radius, for example, crossing media and reaching the margin of the wing back of the latter, it is an ordinary occurrence for seta ii to be found above i, for seta v to take almost any position with respect to iv, and for vii to consist of one, two, three, or many setae, either approximate to each other, or decidedly remote in position.

In place of the numerals now in use the writer suggests Greek letters. They combine a quickly written character for labeling plates and an easily pronounced word with which all scientific men are familiar. A special letter can be introduced for a subprimary seta in a limited group without disarranging the system. The alphabetical order is not so fixed in the mind as to prejudice one in regard to homology. At the same time the confusion introduced by the papers of Quail and Forbes in Dyar's system is avoided and, as long as the Greek letters are retained in the original sense, the meaning will be absolutely clear.

As it is convenient to have a single term for groups of setae and for compound tubercles, such as scoli, the writer capitalizes the letter indicating one of the more constant of the primary setae composing the group. For example a verruca bearing a tuft of setae developed from the group consisting of theta, kappa, and eta, is known as the verruca of the Kappa group and labeled "K" (cf. Figs. 7 and 25). In cases where there is doubt about the number of primary setae from which a scolus or verruca is developed, the capital letter is usually employed. This method is particularly valuable where it is impossible or disadvantageous to indicate the components of the group. The names of the groups and the setae composing them are given on page 39.

As mentioned on a previous page, a seta is known as primary when it is present on the newly hatched larva. If it first appears after one of the molts but is fairly constant, it is known as subprimary, e.g., mu, theta, etc. Secondary setae are those which have no constant position, are more or less numerous and scattered, are not ancestral, and bear absolutely no relation to the primary setae. They are very rarely found in the first instar. The individual setae of a tuft borne on a verruca are not given distinctive names, the group itself being called primary or subprimary according to its origin. The numerous setae which it bears are not considered secondaries.

IV. Setal Arrangement in the Principal Superfamilies

In this section the larval chaetotaxy of a number of typical species is described. Each seta is named when it is first mentioned in the description, the same name being applied to its homotypes on other segments and other larvae as they are reached. While it is not feasible to discuss their homology in detail in this place, some of the evidence supporting the view expressed is usually given, except where the correspondence is entirely obvious. Section V then takes up each seta in turn, follows it through its principal migrations and modifications, and briefly summarizes the evidence for each case of homotypy.

SUBORDER JUGATAE

Of the suborder Jugatae the writer has studied in detail but one genus, Hepialus, and the description will be limited to it. The setae of larval Micropterygidae have been so reduced by leaf-mining habits that conclusions can not be based on them. Hepialus, on the other hand, seems still to be generalized and, as its wings gave Comstock the clew to the ancestral venation, so its chaetotaxy has suggested the generalized setal plan.

Had Dyar studied the prothorax of the larvae of this genus as carefully as he did the other segments the following description would not be necessary. As it is, the writer is compelled to rely on his figure of the first stage; for up to the present time no newly hatched larvae have been available for study. As this first stage is essential in the determination of homology, my results are based on the assumption that his figures are correct. Descriptions of the later stages in this paper were made from *Hepialus humuli,* verified by comparison with *H. hectus* and *H. lupulinus,* two or more individuals of each species being studied.

First Instar

[Figs. 2, 3, 4]

The prothorax of the newly hatched larva (Fig. 2) bears six setae above the spiracle, two in front of it, two between it and the leg, and one in front of the leg. No ventral setae are indicated. Those above the spiracle are in two transverse rows of three setae each, those in the caudal row being much closer together and farther ventrad than those of the cephalic row. As shown on the figures, I have named those on the cephalic row, alpha, gamma, and epsilon, and the caudal group, beta, delta, and rho, beginning in each case near the dorsomeson. In front of the spiracle, kappa and eta represent the Kappa group, and between the spiracle and the leg the two setae, pi and nu, form the Pi group. The seta in front of the leg is tau.

The mesothorax and metathorax (Fig. 3) are practically identical in their arrangement. As there is no spiracle, let us describe the setae as above and below kappa, the single seta at the level of the prothoracic spiracle. Above it are only five setae, two in a cephalic and three in a caudal row. The homology is perfectly evident, gamma, the middle of the three setae of the prothorax, being the only absentee, and alpha, beta, delta, rho, and epsilon having the same position as before. Below kappa is located pi, the caudal seta of the Pi group. Tau occupies the same position as before.

We thus find that all the thoracic segments in this instar are arranged on the same plan but that the prothorax bears three more setae, gamma, eta, and nu, than the other two segments. Whether these setae have been lost from the second and third segments or added to the first will be discussed in a succeeding paragraph.

On the abdomen (Fig. 4) above the spiracle there are only four setae, two in each transverse row. The cephalic row, exactly as in the metathorax, consists of alpha and epsilon, but in the caudal row delta is wanting. Four of the six dorsal prothoracic setae are then retained on the abdomen. Of the lateral setae, kappa and eta are both present as on the prothorax but they are widely separated. It will be shown later that this separation is not of great importance in showing the ancestral condition or the homotypy, for on the abdomen of the Microlepidoptera, kappa and eta are approximate as they are on the prothorax. Unquestionably they have been derived from the same source on all the body segments.

At the base of the proleg are found two cephalolateral setae and one cephalic seta. The first two are almost directly behind pi on the metathorax and clearly represent pi and nu. As the other is in front of the proleg and bears the same relation to it that tau does to the thoracic leg, it doubtless represents that seta. We may therefore conclude that the arrangement of the abdominal setae is homotypic with that of the prothoracic.

Later Instars

[Figs. 5, 6, 13, 14]

The mature larva of Hepialus differs in some important particulars from the condition in the first stage. Most of these differences were pointed out by Dyar and their bearing on phylogeny was discussed. Our point of view is somewhat different from his, for we are considering homotypy, a field which he did not enter.

The most striking change brought about at the first molt is the appearance of a certain seta, theta, on each segment. This is always caudad of kappa and dorsad of it on all but the prothoracic segment. It is the best established subprimary seta in the whole order, for it suddenly appears at the first molt on all the segments of Hepialus and on the mesothorax and metathorax of Frenatae. Another late arrival is omega, situated between nu and tau on the abdomen. Whether it is present in the first stage on the thorax, I do not know, but in the mature larva it is on the ventral surface of the thoracic as well as of the abdominal segments.

The mature larva of *Hepialus humuli* may then be described as follows:

Prothorax (Fig. 5). Six setae are located above the spiracle and three in front of it. All of these are placed on the cervical shield, which extends ventrad to the level of the middle of the spiracle. Along the cephalic border of the shield are five setae the upper three of which are alpha, gamma, and epsilon, as described on the first-stage larva. The lower two, kappa and eta, in front of the dorsal margin of the spiracle, are lateral in position and belong to the Kappa group. On the caudal margin of the shield is a group of three setae, beta, delta, and rho, arranged in a curved line directly above the spiracle. Slightly separated from these is another, ventrad of the lower end of this line. The latter is theta, the third member of the Kappa group, and is always associated with kappa and eta.

Near the coxa of the leg is a chitinized plate bearing two setae, pi and nu, representing the constant and important Pi group. In front of the leg are certain small setae, usually two in number, with a third sometimes added. These I call the Tau group, for they are extremely variable and it is difficult to homologize the individual setae. They are, however, not related to each other in the same sense as the members of the Kappa group, Pi group, etc. The one closest to Pi may be called omega, and the others, tau and phi. Behind the coxa, as in all caterpillars, sigma is present near the ventromeson.

Mesothorax and Metathorax (Fig. 5). These segments are each divided into three annulets, marked distinctly on the dorsal half of the segment but partially lost on the ventral. On the first of these is found a group of three minute setae, which must represent gamma or a structure developed in its place. As it is in the position of gamma it is most convenient to give it that name altho the evidence is not conclusive. The middle annulet bears two setae, one near the dorsomeson, the other directly caudad of the prothoracic spiracle. These, as in the first stage, are clearly homologous with alpha and epsilon. Assuming that the homology suggested in regard to the first annulet is correct, we now have the entire row, alpha, gamma and epsilon, accounted for.

The third annulet bears three subdorsal setae and two lateral ones. The three subdorsal are plainly beta, delta, and rho, as on the prothorax. They are somewhat more dorsal in position and not so close together, but otherwise clearly represent the same structures. The two lateral setae are in the same position as the Kappa group. The caudal one is clearly theta, for it was not found on the newly hatched larva; but the other may be either kappa or eta. I have labeled it kappa, altho there is no evidence in this one species that it may not have developed from eta instead. We shall see, however, that eta, when present on the thorax, as in most of the Frenatae, takes a position quite distinct from that shown here, while kappa is usually found in this place. The homology as given, is therefore undoubtedly correct.

Laterad of the leg and close to the coxa is a single seta, often borne on a chitinized plate. This is pi, the only representative of the Pi group ever found on the mesothorax except in a few cases. The Tau group and sigma are also present.

Abdomen. The relation of the type of arrangement of the setae of the abdomen (Fig. 13) to that of the thorax can not be determined from a study of the mature larva alone. This is due to the addition of several new setae at the first molt and the changed position of others. As in the first instar, there are four setae above the level of the spiracle, but these do not so clearly represent the two transverse rows as before. The ventral seta of the caudal row, rho, had migrated cephalad to the middle of the segment even before the first molt and is now found very close to epsilon and associated with it above the spiracle. The fact that this is actually rho and that it has come from the caudal part of the segment can not be doubted after seeing figures of the newly hatched larva and studying the record of this seta throughout other members of the order.

In the spiracular region are three setae in a diagonal line, theta and kappa caudad of the spiracle and eta some distance ventrad. Kappa and eta were noted in the first instar but theta was missing. The latter's relative position on the abdomen is the same as that of its homotype on the thorax.

Below eta the maximum number of setae on any segment except the last is five. These are arranged differently as we pass caudad. In *Hepialus humuli* all are present on the first six abdominal segments, but one of those on the first segment is much smaller than the others. It is entirely missing from this segment of *H. lupulinus* and *H. hectus.* On the second segment the arrangement is more typical. Two setae, pi and nu, are close together near the middle of the segment and only slightly more ventrad than their homotypes on the thorax. Sigma is present as usual near the ventromeson. This leaves only two setae, and they are in the same position here as the Tau group on the thorax, so the entire homology is clear, as labeled on the plate.

On the proleg-bearing segments, omega varies between a mesocephalic position at the base of the leg in some species to a laterocephalic location in others. In the latter position it is quite closely associated with the Pi group and seems to belong to it rather than to the group from which it was derived. On segments 7, 8, and 9, it is, however, wanting, so that these segments bear four subventral setae, nu and pi representing the still bisetose Pi group, tau alone remaining of the group which bears its name, and, as usual, sigma near the medioventral line.

In many caterpillars the ninth abdominal segment shows a very puzzling condition, analogous to that on the mesothorax. There is a tendency for the setae to arrange themselves in a single transverse line, challenging the investigator to say which is which. The larvae of Hepialus (Fig. 14), however, have not undergone so much change, and homologizing the setae on this body-segment is not so difficult. As usual alpha and beta are found near the mediodorsal line with rho and theta below them. Epsilon, altho present on the preceding segments, is wanting here, but it is such an evanescent seta that its absence in this place is not surprising. Kappa and eta are somewhat closer together and farther caudad and dorsad than before, but the homology is clear. This leaves only the subventral setae, which, as was stated in the last paragraph, are identical with those on segments 7 and 8.

The most difficult problem of all still remains and we can give it only a partial answer. Had we all the ancestors of Hepialus there might still be a doubt as to the meaning of the anal segment. Is there a tenth segment and then a telson representing the eleventh? Does the proleg belong to the tenth or to the eleventh segment and does it bear the setae of both segments or of only one of them? What is the origin of the setae on the caudal aspect? The condition in Hepialus larvae is as follows:

On the dorsal half of the last abdominal segment (Fig. 14) is a semicircular plate whose diameter is the cephalic border of the segment. On each side of the meson this plate bears three setae, two in a longitudinal line comparable to the position of alpha and beta on the other segments, and one farther laterad and cephalad. Between the plate and the anus is a pair of fleshy projections, the suranal lobes, each bearing one seta on its caudal aspect. Below the anus another pair of lobes and the prolegs bear a total of eight setae. Two of these are on the caudal aspect of the ventral lobe, four on the lateral aspect and one on the caudal aspect of the proleg, and the other cephalad of the proleg.

In the first place it should be noted that while it is possible to name these structures, there is no great amount of evidence as to their true homology. If we call those on the plate epsilon, beta, and rho, then the one on the suranal lobes must be theta. This would indicate that the tenth segment is very similar to the ninth and gives us a hint as to the other setae. The one on the mesocephalic aspect of the proleg would thus be tau, and the one in a mesocaudal position, sigma, while the four on the lateral aspect would represent pi, nu, omega, and phi. Calling the two setae behind the proleg kappa and eta, completes the series.

These setae have been named not so much to express an opinion regarding their homology as to show that only one set is present. There is only one more seta (phi) on this segment than on any of the other proleg-bearing ones and one (epsilon) is missing. We may consequently conclude that the setae give no evidence for considering the anal segment to be composed of more than one metamere either in its dorsal or ventral portions. The proof is especially clear either that the suranal plate does not represent a telson, or that if it does the dorsal half of segment 10 has been entirely suppressed. Those who have asserted that the setae show that this segment consists of more than one somite have not studied carefully the data on which their opinions were based.

Conclusions from a Study of Jugatae

Hepialus has been considered in detail because it is very close to the typical form and represents an entire suborder, the Jugatae. There are some primitive features about it which give us a clue to the homology in other groups. This is especially true of the thoracic segments, whose relation to the abdomen and to each other would be wholly in the dark without this form. The prothorax shows the same essential type of arrangement as the other segments. It has been a failure to study Hepialus carefully that has caused Müller, Dyar, Quail, and Forbes to omit the prothorax in their work on the setae and to consider its chaetotaxy as of wholly different origin.

SUBORDER FRENATAE

The chaetotaxy of the larvae of this suborder has been described in detail by Dyar, and he has also compared it with the setal plan of the Jugatae. A brief consideration of those modifications of the plan which might be confusing in a determination of homotypes is all that is necessary here.

Bombycoidea

The Noctuidae are considered first, not because they are the most generalized but because the writer has studied no other larvae in the first instar.* The setal plan of *Feltia gladiaria* in this stage shows a close correspondence to that of the newly hatched Hepialus larva. On the prothorax (Fig. 17) eta of the Kappa group, all the Tau group, and sigma are wanting. Otherwise the homology is clear. The mesothorax and metathorax (Fig. 18) show a condition which has probably been developed on account of the great mobility of these segments. The setae are in a single transverse row. Above kappa, located caudad of the prothoracic spiracle, are four setae instead of the five borne by Hepialus. The missing one proves to be delta, for the close correspondence with the abdomen shows that the dorsal two are alpha and beta; and the others are undoubtedy epsilon and rho, which are usually associated together on all segments. Below kappa is pi, near the proleg. As on the prothorax, the Tau group and sigma are wanting.

The abdomen (Figs. 19, 20, 29) shows alpha and beta in their usual positions near the dorsomeson except on the first few segments, where they are more nearly in a transverse row, similar to their arrangement on the metathorax. Just dorsad of the spiracle is rho, a well-developed seta, and in most cases a minute point representing epsilon. The latter, known as iii a in the literature, is often considered subprimary, but the presence of this rudiment, which Bacot (Quail, 1904) says is of common, if not universal, occurrence in all stages of the larvae of Frenatae, proves it to be primary. Its small size is the result of reduction, rho having migrated caudad to the region it once occupied. The other abdominal setae are just as in the first-stage Hepialus. In Feltia, tau is not present, but in most Frenatae it is said to be associated with nu and pi in all instars and is usually considered a member of the Pi group. Its absence from the first, seventh, and eighth abdominal segments is a common occurrence. Sigma is located near the medioventral line as usual.

The homology of the setae of segment 9 (Fig. 30) may be solved by a comparison with the same segment of the mature Hepialus larva and a study of other species which form connecting links between the two conditions. The evidence for considering the most cephalic of the subdorsal setae as alpha, will be given in the next section. Beta is much closer to the dorsomeson, as on the prothorax. The presence in some species of a minute seta (epsilon) close to the third seta shows the latter

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*Careful descriptions of first-stage larvae of many other groups have been published, the prothorax usually being omitted. Since sending this paper to the printer, the first instar of *Prionoxystus robiniae* (Cossidae) has been examined by the writer. Its prothorax is identical with that shown in figures of Hepialus in this stage, differing from noctuid larvae in the presence of two setae, instead of only one, in the Kappa group.

to be rho. This leaves only three setae, which are certainly kappa, pi, and sigma. All of these conclusions are based on series of intermediate stages.

Segment 10 bears only one seta less than in Hepialus but the homology is not clear.

The mature Feltia (Figs. 21 to 24, 31, 32) shows certain modifications of the chaetotaxy of the first stage. The arrival of theta and gamma on the mesothorax and metathorax, the first caudodorsad of kappa, the other near the cephalic border of the segment, are the only changes duplicated on Hepialus. On all the thoracic segments eta appears ventrad of kappa. As it was not present at all on the last two segments of Jugatae, the condition here shows that since its establishment on the abdomen it has arisen on the thorax, where, under Weismann's law, it has not yet reached the first instar. Finally mu, the most recent arrival of all the subprimaries, appears caudoventrad of eta on the first eight abdominal segments.

A significant change in position also occurs after the first molt. Epsilon, located below alpha and gamma in the cephalic subdorsal row of the prothorax in the first stage, now appears close to rho above the spiracle. This migration distinguishes the Bombycoidea from the Microlepidoptera, for in the latter group epsilon remains near the cephalic border of the prothoracic shield.

Microlepidoptera

Altho the differences between the Noctuidae and the Microlepidoptera are not great, the latter are more generalized in some important particulars. These are best shown by Pseudanaphora (Figs. 7, 8, 15, 16), a member of one of the most generalized families of the order. On the prothorax theta is present, so that all three setae of the Kappa group are accounted for, just as in Hepialus. On the abdomen, kappa and eta are at the same level but still distant, altho in all the higher micros these setae are close together below the spiracle. As in the noctuid abdomen, mu is present and theta is wanting. Segment 9 shows nearly as many setae as in Hepialus, there being only two important differences; the absence of tau and theta, and the presence of mu caudoventrad of eta as on the other segments.

Other Groups

The high specialization of the armature of saturnian, sphingid, and butterfly larvae lessens their value as evidence on the homology of the setae. The first instar is usually similar to that of the Noctuidae. Only one serious problem is presented, viz., the origin of the scolus Kappa in the Saturnioidea. Whether this consists of kappa and eta or eta alone is a disputed point, altho the first instar seems to indicate the correctness of the former view.

V. Primary and Subprimary Setae

In the following discussion of the setae, the evidence for each case of homotypy is briefly summarized. The plan followed is that already outlined herein under the title, ''Application of the Evidence.'' Other authors have indicated various conceptions of homotypy in labeling their figures but none have presented proof, except in one case, the brief paper by Quail mentioned in the introduction. As the evidence on all the important points is conclusive, the retention of an unnatural or uncertain nomenclature is no longer defensible.

Alpha. The position of this seta as given in the descriptions of the groups is so clear that a few words here will suffice. Originally alpha seems to have been farther dorsad as well as farther cephalad than any other seta. This is now true on all the segments of Hepialus, on the abdomen of nearly all Frenatae, and on the prothorax of many Tineidae and Yponomeutidae. The prothorax shows beta nearer the meson than alpha in nearly all the higher Frenatae, but this is clearly a later migration.

Alpha is always present in the first stage and is therefore primary. It is one of the most persistent setae and usually forms a verruca or scolus in species bearing these structures. Whether it is present or absent on the last two thoracic segments of Frenatae will be discussed under ''Beta'' on a later page.

On the ninth abdominal segment of most Frenatae, alpha is located farther laterad than beta, and in the Macrolepidoptera, this condition has gone back into the first instar. But in Hepialus (Fig. 14), Scardia (Fig. 54), Thyris (Fig. 55), and other genera, it is still as close to the dorsomeson as on the other abdominal segments. In Pseudanaphora (Fig. 16) the lateral migration has already begun and in certain Pyralididae (Fig. 49) it is carried to its greatest extent. In many families the location of this seta is a character of importance in the classification of genera (cf. Pyralididae, Tortricidae, etc., Part Two). The close association with rho in some cases seems to cast doubt on the view that this seta is homologous with alpha; but the position in generalized larvae, the complete set of intermediate stages connecting it with its other locations, the variation between the original and later positions within limited groups, and the fact that beta, epsilon, and rho are otherwise accounted for, show unquestionably that this seta must be alpha.

Beta. On the prothorax as well as the abdomen beta is always the dorsal seta of the caudal row. Its position varies from that in Hepialus

(Fig. 5), where it is about half way between the spiracle and the dorsomeson, to that in most Frenatae (Fig. 21), where it is closer to the dorsomeson than any other seta of the segment. Intermediate stages are shown by Yponomeutidae (Fig. 35) and Acrolophidae (Fig. 7).

The specialization of the mesothorax and metathorax of Frenatae has been mentioned. No intermediate stages exist to show the relations between the setal plan of these segments of Hepialus and those of Frenatae. A comparison of the thoracic with the abdominal segments of the newly hatched larva of Feltia (Figs. 18, 19, 20, 29, 30), however, indicates the direction the migration has taken. Segments 6, 7, and 8 show alpha and beta in their normal positions while on segments 1 and 2 beta is almost directly ventrad of alpha. The large number of groups in which these two setae are associated in the abdomen, either by being borne on a single pinaculum, or uniting to form a single verruca, shows that they may easily become adjacent. The conclusion is therefore justified that the two dorsal setae of the mesothorax and metathorax are alpha and beta, in spite of their changed position. Hofmann, Dyar and Quail agree that this is the true condition.

Gamma. This seems to be a comparatively new seta on all but the prothorax, where it has become established. The newly hatched larva bears it only on the one segment and there its position is constant. It is often represented on meso- and metathoracic and abdominal segments as a more or less minute subprimary seta near the cephalic border of the segment and in Hepialus is associated with two other smaller ones. While there is some doubt about the accuracy of considering a primary seta of the prothorax homotypic with the subprimary one of other segments, the fact that the two bear exactly the same relations to the other structures of the segment makes it inadvisable to use a different name. This will be discussed under ''Eta'' on a later page. The probability is that gamma is a more recent seta than the other primaries and became first established on the prothorax, the order of appearance on the different segments now being shown by ontogeny.

Delta. Between beta and rho on the prothorax of all caterpillars and also on the other thoracic segments of Hepialus is delta, a seta never found in any other position or on any other segment. If ancestral, it has since become lost on the abdomen of all lepidopterous larvae and on the last two thoracic segments of all Frenatae.

Epsilon. The prothoracic segments of Hepialus and Pseudanaphora bear the third seta of the cephalic row in its typical position. In connection with rho it goes through various changes which are sometimes hard to follow on the other body-segments but are evident on the prothorax. In the Tortricidae (Fig. 39), Aegeriidae, and Yponomeutidae (Fig. 35), this seta remains constant in position while rho moves forward toward it. This is distinctly noticeable in Plutella while in *Atteva aurea* (Fig. 36) it has scarcely been begun. The opposite movement is to be noted in all Macrolepidoptera. The newly hatched larva of Feltia shows rho and epsilon in their normal positions distant from each other. In the mature larva, however, epsilon has migrated back to rho, leaving only alpha and gamma remaining in the cephalic subdorsal group.

On the mesothorax and metathorax of Frenatae, epsilon and rho are again found associated. Like alpha and beta they have yielded to the mobility of this part of the body and been crowded to the middle of the segments. The first stage of Hepialus and Feltia show that epsilon is the upper of the two and rho the lower. Both prothoracic and abdominal segments of Hepialus and *Cossus cossus* prove that epsilon was originally above the level of rho and that its present position ventrad of that seta on the abdomen of many of the species we know today has come about through migration.

On the abdomen of Hepialus, the presence and large size of epsilon in the first as well as later instars creates a serious problem if that seta be considered missing from its usual position in the first stage of Frenatae. I have been unable to detect it in the newly hatched Feltia larva but according to Quail (1904), who quotes A. Bacot, it is of general occurrence in all instars of Frenatae. The probability is, therefore, that it is disappearing from the abdomen and is retained in its former vigor only by Hepialus and *Cossus cossus.* There seems to be no evidence that it is in any sense subprimary.

Rho. The principal migrations of rho have been described in the discussion of epsilon. It is present in all instars on all segments of all caterpillars except when obscured in later stages by a secondary armature. Usually it is associated with epsilon when that seta is present. In species bearing verrucae, epsilon never forms one distinct from that of rho, except sometimes on the mesothorax and metathorax.

Theta. The dorsocaudal seta of the Kappa group needs consideration merely to prevent its confusion with other setae. No question can be raised as to its homotypy on the segments of Hepialus, where it is subprimary throughout, in all cases being dorsad and caudad of the primary kappa. The same is true on all thoracic segments of the tineoid series of Microlepidoptera and on the meso- and metathorax of Pyralidiæ and Macrolepidoptera, where it is present and subprimary.

Some confusion might arise concerning it on the abdomen of Frenatae in those cases where kappa is well toward the upper border of the spiracle. The fact that kappa is usually much lower down, and is often associated with eta, indicates the error of a view which would call this seta theta. This is further emphasized by the subprimary nature of theta and by the fact that eta and kappa already have homologues on Hepialus without the use of theta. Forbes' (1910) error on this point was rather far reaching so far as homotypy is concerned. He gives only four figures, but in the setae epsilon, theta, kappa, eta, and mu, there are four cases* in which the same label is given in one place to a primary and in another to a subprimary seta. Most of these associations would be very difficult to explain and they are wholly unnecessary. The mistakes are due, not to errors in observation, but to a failure to take the primitive first stage into account.

Kappa. This is a fundamental, ancestral, primary seta and is readily transformed into a scolus or verruca. It occupies a position about the level of the spiracle and is almost never absent. In forming verrucae it is often associated with theta and eta, and on the prothorax of most of the Microlepidoptera a chitinized pinaculum bears all three. In specialized Microlepidoptera kappa and eta are always adjacent on the abdomen, where they take all possible positions with respect to each other. In most cases the dorsal of the two is called kappa.

On segment 9 kappa is obsolete in certain Pyralididae. The beginning of the reduction is shown in Phycitinae (Fig. 46) where eta is located on the same pinaculum with kappa and mu but is much larger than the other two. In Pyraustinae (Fig. 49) only eta remains. This condition is not sufficient, however, to justify us in calling the sole representative of the Kappa group on the ninth abdominal segment of Noctuidae, ''eta'', for here the position on the newly hatched larva, especially in its relation to rho and pi, shows that it is the caudal rather than the cephalic seta of the group which has been retained. (See Fig. 30.)

Eta. On the meso- and metathoracic segments of the Frenatae, eta, like theta, appears at the first molt. It is below kappa and is often associated with it. On Hepialus it is wanting on the mesothorax and metathorax but present on the prothorax. At the time of the separation of the Jugatae from the Frenatae it had appeared only on the prothorax and abdomen or had been lost on the other thoracic segments. In the latter place it has since become established in the Frenatae after the first instar.

This is one of two cases where it has seemed necessary to consider

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*These are: iii (primary in all except Fig. 4); iv (primary on Figs. 4, 5, and 34, subprimary on Fig. 33); v (primary on Figs. 5, 33, and 34, subprimary on Fig. 4); vi (primary on Fig. 33, subprimary on Figs. 5 and 34).

a subprimary seta on one segment the homotype of a primary one on another. The fact that in Hepialus eta is present on both the prothorax and abdomen but that there is no seta with which it can possibly be homologous on the mesothorax and metathorax, shows that in the latter place its homotype has either been lost or has never appeared. The same conclusion is indisputable after a study of first-stage Frenatae. Since the separation of the two suborders a new seta has appeared on the caudal thoracic segments in line with eta of other parts of the body. This new seta bears the same relation to the other structures of the segment as eta does and associates with kappa in the same characteristic way. While its later appearance makes it doubtful whether the mesothoracic seta should be called a homotype of the one on the abdomen, it is clear that no object would be served by merely attaching to it a new name. We therefore depart to that extent from a strict interpretation of our definition of homotypy.

Pi. Considerable confusion might exist at first in regard to the homology of this and neighboring setae. The description of the ventral half of the larva of Hepialus shows that the homology there is evident enough. Any other interpretation would involve one in endless complications and would necessitate a total neglect of the generalized first larval stage.

In Frenatae, however, the prolegs are much farther mesad than the thoracic legs and the setae of the two regions have a less apparent relation to each other. This is complicated by the arrival of mu which is directly caudad of the thoracic pi and appears to be analogous with it. Fortunately the condition in the newly hatched larva proves the analogy to be more apparent than real, for mu is not present in the first instar. This is so constant a character that Dyar distinguishes the Jugatae from the Frenatae by the presence of this seta, ''vi'', after the first molt in the latter group while it never appears in the former. In spite of this fact, Dyar, Forbes, and others usually label pi on the thorax, ''vi'', indicating that it may be homotypic with mu of the abdomen. For that reason the group requires more extended discussion than the others have received. In the following summary of the evidence on this point, ''Pi'' is used for the Pi group of one or two setae at the base of the thoracic legs, ''mu'' for the subprimary on the abdomen, and ''vii'' (following Dyar) for the lateral two of the group of three setae on the prolegs which we are convinced are homotypic with ''Pi''.

Pi must be homotypic with vii in Hepialus for mu is not present. (Figs. 5 and 6.)

The first instar of larval Frenatae indicates the homotypy of Pi and vii, for no other interpretation is possible in the absence of mu (Figs. 17, 18, 19, 29.)

Pi and vii, in addition to the fact that both are primary, are both "double" in all stages on the prothoracic and abdominal segments and sometimes on the mesothorax and metathorax, while mu is always single.

The multiple nature of Pi and vii is indicated by the newly hatched larva of Panorpa, of the Mecoptera, described by E. P. Felt, 1895. Its prothorax bears the same setal plan as that of lepidopterous larvae and while the setae of the other segments of Panorpa are reduced in number the fundamental arrangement is the same. On every segment there is a pinaculum bearing four to six setae in a longitudinal row situated at the base of the leg or the proleg as the case may be. The fact that this is the first stage, all the setae being lost later, and that the Mecoptera are usually considered more generalized than the Lepidoptera, would seem to indicate that Pi originated as a multisetiferous tubercle and that the setae had been reduced to the definite number two on modern caterpillars.

Scolus-bearing larvae also indicate the homotypy of Pi on the thorax to the group called vii on the abdomen. In Saturniidae, e. g. *Samia cecropia* (Fig. 107), each thoracic segment bears a scolus at the base of the leg, and in line with these scoli are found similar ones on abdominal segments 1 and 2. The latter are not present, however, on segments 3 to 6. As usual, vii of the proleg-bearing segments is modified into a multisetiferous plate and not into a thorn-like process. If the scoli on segments 1 and 2 represented the seta "vi" or mu, they would also be found on segments 3 to 6 near the base of the prolegs, as in arctians and other verrucose larvae, for mu never takes part in the formation of a multisetiferous leg-plate. These scoli must then be homotypes of vii. But they are also indisputably homotypic with Pi on the thorax. Therefore Pi and vii are homotypic and vii should be called Pi.

Dyar (1901) interpreted this condition correctly and Quail (1904) agreed with him. The views expressed in this paper are in accordance with those of Quail on all the setae which he studied. A careful interpretation of the evidence must convince one that Pi is homologous with "vii" of the abdomen and has no relation to mu.

Mu. Mu, as has been said, arises at the first molt of Frenatae between eta and the Pi group. Apparently it is homotypic with pi of the metathorax, but its absence from Hepialus, Panorpa, and the first stage of all caterpillars, shows that this is out of the question. What, then, accounts for its presence?

The fact that the prolegs, and consequently the Pi group, on the abdomen are farther mesad than the thoracic legs has been noted. This change, which is barely indicated in the Jugatae, leaves a considerable space between eta and pi on the abdominal segments. Assuming that the setae are sensory in function, it is clear that the presence of a sense organ in this important area would be of selective value. A discussion of the method of origin of new or secondary setae in response to a need on the part of the organism would be out of place here, but that they do arise and are of importance to the life of the caterpillar is shown by the conspicuous differences between the mature larvae of different families. In this case mu appeared in the center of an area left vacant by the mesal migration of the prolegs and the Pi group, and has been retained because it is, like the other sense organs of the larva, an adaptation to the conditions of existence.

Sigma. Near the medioventral line of almost every lepidopterous larva, sigma may be found in nearly the same position on every segment. So far as known it is never associated with other setae except in some groups in which it is drawn into the formation of a multisetiferous leg-plate.

Tau. The name Tau has been given to an indefinite group of setae between pi and sigma. Various numbers are present, ranging from one to three or four, or the entire group may be absent. So far as known, only one is ever present in the first instar. This is the cephalic or mesal seta of the group of three at the base of the proleg on Frenatae and newly hatched Jugatae. Dyar calls all three the ''tubercle vii'' but a very little study of the first two abdominal segments shows that the two caudolateral members of the group have a distinctly different origin from the other. When four setae are found upon this aspect of the proleg, as in Hepialus, the additional one is considered as another member of the group Tau. In the description of this genus on a previous page the individual setae of the group were named, but that is scarcely necessary in Frenatae.

VI. General Conclusions.

The setal arrangement of every segment of the body in larvae of the Lepidoptera has been derived from the same ancestral type.

This type includes twelve primary setae: alpha, beta, delta, gamma, epsilon, rho, kappa, eta, nu, pi, tau, and sigma.

The primary setae are present in the first instar. They became established before the suborders of Lepidoptera separated from each other and possibly before the separation of the order from other Holometabola. It is not necessary to assume, however, that there ever existed a single insect larva having the setal plan of all the segments similar and including only the primary setae as given above.

The ancestral type has been modified in three ways, each being more or less independent of the other two. *(a)* The prothorax shows a tendency to retain the maximum number of setae; this is a response to the numerous sensory stimuli which this segment must transmit. *(b)* The mesothorax and metathorax show a partial reduction and considerable modification in response to the necessary mobility of this portion of the body. *(c)* The abdominal chaetotaxy has also been reduced but the setae tend to retain their original typical position. Segments 9 and 10 show specialized modifications of the setal arrangement of segments 1 to 8.

Subprimary setae are those which, altho they have a definite location on the mature larva and are rather persistent, are absent from the first instar.

New setae have usually appeared first in that part of the body in which they were of most benefit, e. g., gamma on the prothorax and eta on the abdomen. In some cases setae which seem to be homologous with them have arisen later on other segments. The order of their appearance is now shown in ontogeny.

In addition to the doubtful subprimary homotypes of gamma and eta, there are two rather persistent subprimary setae: theta, which is found on the mesothorax and metathorax of both suborders and on the abdomen of Jugatae; and mu, which is more recent and appears only on the abdomen of Frenatae.

Subprimaries of less common occurrence are omega and phi of the Tau group, while still others are present in certain families.

Primary or primary and subprimary setae tend to associate with each other in groups. These groups are indicated in this paper by capital letters.

The Beta group consists of alpha and beta; Rho, of epsilon and rho; Kappa, of theta, kappa, and eta; Pi, of pi and nu; and Tau, of tau, omega, and phi. On the abdomen tau is associated with the Pi group.

Both primary and subprimary setae may develop into tufts borne on verrucae. The verrucae of the same setal group tend to coalesce, while those of different groups tend to remain distinct.

SYNONYMS

In the following tables are given the names used by various authors for the different setae on the segments heretofore studied. A parenthesis indicates that the seta is subprimary in the region of the body referred to. ''O'' indicates that the seta is absent from that region; while a dash is used when the author fails to mention the seta.

Mesothorax and Metathorax. (Frenatae)

	Dyar, 1895	Dyar, 1901	Quail, 1904	Forbes, 1910
alpha	i a	i	i	i a
beta	i b	ii	ii	i b
(gamma)	—	—	—	x
delta	o	o	o	o
epsilon	ii a	iii	iii a	ii a
rho	ii b	iv	iii	ii b
(theta)	iii	v a	iv	iii
kappa	iv	v	v	iv
(eta)	v	v b	vi	v
(mu)	o	o	o	o
pi	vi	vi	vii	vii
nu	o	o	o	o
tau	—	—	—	ix
(omega)	—	—	—	—
sigma	viii	—	—	viii

Abdomen

	Müller, 1886 Nymphalidae 1st stage	Dyar, 1895 Frenatae	Dyar, 1901 Frenatae	Quail, 1904 Frenatae	Forbes, 1910 Frenatae	Forbes, 1910 Jugatae
alpha	1	i	i	i	i	i
beta	2	ii	ii	ii	ii	ii
(gamma)	0	—	—	—	x	—
delta	0	o	o	o	o	o
epsilon	—	iii a	—	iii a	iii a	iii a
rho	3	iii	iii	iii	iii	iii
(theta)	0	o	o	o	o	iv
kappa	4	iv	iv	iv	iv	v
eta	5	v	v	v	v	vi
(mu)	0	vi	v b	vi	vi	o
pi	6	vii	vi	vii	vii	vii
nu	6	vii	vi	vii	vii	vii
tau	—	vii	vi	vii	vii	vii
(omega)	0	—	—	—	ix	ix
sigma	—	viii	—	—	viii	viii

PART TWO. SYSTEMATIC OUTLINE OF FAMILIES AND GENERA.

A complete history of the study of caterpillars would begin with work done centuries ago and would include the names of many scientists. It would necessarily embrace all discussions of larvae of the Lepidoptera. There is now in manuscript a list, as nearly complete as such a list can be made, of all published papers containing descriptions of immature stages of American members of this order, but its size is so great that arrangements for its publication are difficult. Nevertheless, no object would be served here by an extended historical account, especially as the results obtained by the older workers were not of such a nature as to aid materially in the preparation of this paper.

The period from Aristotle to the last quarter of the nineteenth century is discussed at some length in the introduction to ''Die Schmetterlinge Europas,'' the third edition, edited by Arnold Spuler. Since that time the subject has been put on a more scientific basis by the work of two men. Dr. Harrison G. Dyar, in addition to the papers mentioned in Part One, has written excellent descriptions of new larvae for various publications every year for a quarter of a century. These are undoubtedly the best descriptions of larval Macroheterocera extant, for they give not only color but the structural characters which indicate their family and sometimes their generic position. Since 1905 several papers have been published by Dr. W. T. M. Forbes, who has made a detailed study of the head sclerites, mouth parts, and prolegs of a large number of species. Representatives of all the more important families of Macrolepidoptera have been described and figured. The observations of Dyar and Forbes mark the first advance stride toward an accurate knowledge of the structure and relationships of the larvae of this order.

In spite of the work of these investigators certain gaps remain in our knowledge, especially of those species of importance to economic entomologists. The most conspicuous of these is our ignorance of the structure and taxonomic characters of the larvae of the Microlepidoptera. It is true, as one author puts it, that ''there seems to be little variation in these forms,'' but the characters are present and their obscurity merely challenges us to closer search. Another demand of economic workers is an analytical key to the families. Dyar's few tables are usually not adapted to the identification of individual specimens, for he uses characters which, in the later stages of many species, are completely obscured by secondary setae or entirely lost. The best key thus far published is that by Forbes (1910), but it omits nearly all the Microlepidoptera as well as the more obscure families of the larger moths and butterflies. There are species he had not seen which trace to families in which they do not belong, but such a fault is one a worker on immature insects is unable to avoid.

In several respects a systematic outline of larvae differs from a classification of a group of imagines. It is clear that while a difference in larval characters indicates a phylogenetic divergence just as surely as does a variation in adult structure, similarity in the adults of a group of genera does not necessarily indicate the presence of common characters in the larvae. One always faces the fact that he is working with genera and families established on adult characters and that the unknown species of a particular group may be very different from those with which he is acquainted.

Another element of doubt is caused by the necessity of breeding. One can not breed a specimen and keep it too. Larvae must always be identified from the adults into which their *associates* develop except when they are raised from fertilized eggs laid by a known female. The danger of mistaken records can be greatly reduced by careful work but when handling large numbers of species can never be wholly eliminated.

It should also be noted that the adult state represents a single instar while the larva undergoes several molts, changing materially at least once. Wherever possible a description should include all the instars. In this paper, only the more mature larvae were considered, as a rule, but in most families the characters used apply to all except the first or the first and second stages. Usually only the colors change after the second molt.

These sources of error were reduced in importance by the confirmation of observations on long series of individuals. The larvae of several large collections were examined, with the result that several mistakes due to these causes were corrected.

CHARACTERS USED

Adult insects are identified mainly on characters of the wings, segmented appendages, body sclerites, copulatory apparatus, and vestiture of the body and legs. Of these, all except the segmented appendages and vestiture are either absent or indistinguishable in lepidopterous larvae. The mouth parts and antennae of all but a few species are constructed on the same plan and show such limited variation that little use can be made of them. No one has yet discovered characters of much value in the structure of the thoracic legs, so uniform are they throughout the entire order. The vestiture is also entirely different from that of other insects. It is consequently necessary to seek other characters than those with which entomologists are usually familiar and to introduce new terms to describe them.

The structures of value in the classification of these larvae are primarily: the head sclerites, head setae, and ocelli; the armature of the body, especially the setae; the shape of the spiracles; the number of prolegs and the arrangement of the crochets they bear; and the presence on the body of humps and gibbosities, eversible glands, or peculiar modifications of the usual organization. These will be taken up in order.

Head parts.—The varying shapes of the head sclerites and positions of the setae are so well shown by Forbes (1910) that they need little attention here. The head capsule consists almost entirely of an epicranium divided into three parts by the forked epicranial suture. These parts are the right and left sides and the front. The latter is usually a triangular sclerite on the facial aspect of the head. To its ventral margin is attached the trapezoidal clypeus which supports the labrum. Laterad of each arm of the epicranial suture is a narrow area, the adfrontal piece (afp, Fig. 78), the exterior indication of the anterior arm of the tentorium. In this region the varying sizes and shapes of the front, the adfrontals, and the labrum, and the location of the setae they bear, are important characters for identification.

At the point where the caudodorsal part of the head capsule joins either the prothorax or the unchitinized portion of the head, there is a pale triangular dorsal area of thin cuticula. The cephalic point of this triangle in all except a few caterpillars is at the caudal end of the epicranial suture and its sides are formed by the caudad projecting lobes of the epicranium. This dorsal area is known as the ''vertical triangle'', or sometimes merely the ''vertex'', although the latter term properly applies to the dorsal part of the head capsule itself. In some leafminers the front extends caudodorsad as far as this triangle and the arms of the epicranial suture do not unite to form a stem. The front in such cases is said to be ''open''. In very small larvae, however, care must be taken in determining this point, for microscopic preparations show the tentorial arms much more distinctly than the epicranial suture, and these internal arms usually do not meet on the vertex. The head setae are numbered according to Dyar's scheme (Figs. 78, 86).

As the head is not a single metamere we can not homologize these setae with those of the body segments.

The ocelli seem to form one of the most satisfactory characters for the separation of genera. In most families their arrangement and the position of the setae associated with them are constant in long series of individuals and species. Without their aid the difficulties in the classification of some of the Microlepidoptera would be almost insurmountable. The dorsal four usually form the quadrant of a circle, with the other two below them and farther apart. (Figs. 70, 71.) Beginning at the caudal ocellus of the dorsal group we may call them the first to the fourth in regular order. The fifth is caudoventrad of the fourth and in some cases farther ventrad than the sixth (Fig. 77) which is the one most cephalic in position.

Armature of the body.—In Part One it was shown that lepidopterous larvae have certain setae in a definite arrangement. These were denominated by Greek letters and their homotypy was studied in order that any particular letter might be made to apply to the same or homotypic setae on every segment of every caterpillar. For that study it was necessary to distinguish between primary and subprimary setae, the latter being missing from the first instar. In classification, however, this distinction is rarely of any value, and as subprimaries are few in number the normal ones are assumed to be present in all mature larvae. A statement in a description that a mature larva bears primary setae only, is to be interpreted on this basis.

The more conspicuous forms of armature are usually associated with groups of setae. ''Tubercles'', ''warts'', and ''spines'' are terms now in use describing them. The first has the disadvantage of meaning any cuticular projection of the body wall from a minute papilla to a conspicuous prominence. ''Spines'' have also been used both for the projections of the body wall and for the branches of any thorn-like process. A number of new terms are therefore suggested for particular kinds of armature. Their derivation is given except where it will be perfectly evident.

In the most generalized larvae a seta is surrounded at the base by a small chitinized ring, very slightly raised. This ring may be called a *papilla,* following Scudder. It is often surrounded by a small and definitely bounded chitinized area or *pinaculum* (L. *pinax,* dim., ''a small plate''), such as is seen in many Microlepidoptera (Figs. 15, 40). When the pinaculum is conspicuously elevated at the center and bears the seta on a distinct projection, it may be termed a *chalaza* (Gr. χαλαζα, ''pimple'', or ''tubercle''), as in the arctian Utetheisa (Fig. 90). Either the pinaculum or the chalaza may be double or triple, and may accordingly bear two or three setae (K, fig. 39); but neither is ever multisetiferous.

When the setae are increased in number new modifications are to be noted in the cuticular areas to which they are attached. The most common tendency is toward the development of tufts, in which case each tuft is said to be borne on a *verruca* (L. *verruca,* "wart") as shown in Fig. 88. If the setae are so thickly grouped as to form a dense upright bundle, the term *verricule* (Fig. 91), already in use in entomology, describes their condition. In some cases the setae are increased in number on a pinaculum without forming tufts, as on the prolegs of notodontians and arctians (Fig. 100). As the term *plate* is already in use for this structure and is not applied to other different conditions, it is adopted here.

More conspicuous than verrucae are the thorny processes bearing spine-like setae, found in saturnian and nymphalid larvae (Fig. 74), and for them the term *scolus* (Gr. κ ολος, "thorn") is particularly appropriate. When the setae are borne on sharp lateral projections of the scolus, these projections are known as *spinules.*

As the word *tubercle* has been applied to each one of the above structures by previous writers, it is deemed best to retain it as a general term.

Spiracles.—A classification of larvae based on the spiracles is still unwritten. It is to be hoped that some future investigator will study their structure and report the variations in different families. As yet little use can be made of them altho differences in their shape, location, and formation can not but be noted. One case in which they are useful is the pyrali-zygaenoid series in which the spiracles become smaller and smaller as the insects become more and more specialized. Certain of these families, such as the Pyromorphidae, can not be easily distinguished from some Bombycoidea by the arrangement of their verrucae, but their small, circular spiracles are very different. (Figs. 79, 104.)

Prolegs.—Nearly two hundred years ago Reaumur figured four or five forms of prolegs and the hooks attached to them. He made no use of them in classification but the figures are more accurately drawn than those of most later workers. Chapman was the first to call attention to the fact that the crochets of Microlepidoptera are usually arranged in a circle while those of the Macros are, in most cases, placed in a single longitudinal row.

Prolegs are normally present on segments 3, 4, 5, 6, and 10 of the abdomen, one pair to each segment. In general statements only the first four pairs are referred to. When it seems necessary to distinguish these specifically from the last pair, those of segment 10 are known as the *anal* prolegs and the others as the *ventral.*

The tip of the proleg on which the hooks or crochets are borne is called the planta. In the most generalized forms (e. g. Pseudanaphora, Hepialus) this planta bears a complete circle of well developed crochets surrounded by several more circles of smaller ones. In Hepialus the differences between the inner and outer are not as marked as in Pseudanaphora (Fig. 96). This arrangement is a *multiserial circle* and is confined to Hepialidae, Acrolophidae, and Yponomeutidae. From it the crochets may be lost in the mesal and lateral parts of the circle as in Adela (Fig. 94), resulting in two *transverse multiserial bands,* which degenerate in Incurvaria to a single transverse uniserial band. Where the outer circles entirely disappear the resulting condition is known as a *uniserial circle* (Fig. 101), for the crochets are in a single, continuous series.

The uniserial circle has the bases of all the crochets in line but the lengths are seldom uniform. We are able to distinguish *uniordinal* crochets (Fig. 105), in which the tips as well as the bases are in a straight line, from the *biordinal* (Fig. 106), in which the crochets are of two distinct lengths alternating. Occasionally *triordinal* crochets (Fig. 98) are seen, but Forbes's separation of Rhopalocera from Heterocera on this basis fails to be confirmed by observation. In fact the irregularities in the lengths of the biordinal crochets make any extensive use of the difference in the number of sizes inadvisable. On the other hand the uniordinal series is usually definite, and the irregularities, except at the ends of the row, are negligible.

Having a complete uniserial circle of crochets, a group may develop *transverse bands* (Fig. 99) by the loss of both the mesal and lateral parts of the circle, or a *penellipse* (L. *paene+ellipsis,* ''almost an ellipse'') by the loss of only a short portion on one side. The penellipse may be *lateral* as in Psychidae (Fig. 85), where the gap in the series is near the meson; or it may be *mesal* as in Pyraustinae (Fig. 98), where the lost crochets were farthest from the meson.

Finally more than half the circle may be lost and a *mesoseries* (Fig. 105) result. This is the arrangement seen in nearly all the Macrolepidoptera except Hesperoidea. In certain families a few rudimentary hooks remain (or are secondarily developed) on the lateral portion of the planta. As there is no case in which these even approach the size of the mesal crochets there is no likelihood of this condition, to which the term *pseudocircle* (Fig. 97) may be applied, being confused with a circle or penellipse.

The crochets of a mesoseries, penellipse, or circle may be either uniordinal or biordinal, as described above. In addition, arctians and a few other families show a peculiar specialization. The planta (Fig. 100) is longitudinally extended beyond the series of well developed crochets, which in these cases are always uniordinal. At each end of this planta is a row of much smaller chitinous processes, usually not hooked. These are often so slightly developed that they are difficult to demonstrate, but the type of arrangement is easily made out by the short row of crochets on the elongated planta. We may apply to this condition the term *heteroideous* (Fig. 100) now used by botanists for ''diversified in form''. In distinction from this, crochets of the ordinary mesoseries are called *homoideous* (Fig. 105).

Modifications, not well covered by the above terms, are found in Megalopygidae and Lycaenidae. In the former the mesoseries makes a sharp angle cephalad of the middle while the crochets near the angle are as short as those at the ends of the series. The genus Carama has a distinct gap at the angle so that the hooks are in two groups. In some Lycaenidae (Fig. 102) there is a similar gap near the middle of the series and from the planta at this point arises a small fleshy protuberance. The latter is present in all members of the family altho in many genera the crochets are merely shortened opposite it instead of being wanting.

Other structures.—Certain genera and families show peculiar specializations which are of value in identification. The most common of these are eversible glands, or osmateria, such as are used in distinguishing Papilionidae, Parnassiidae, and Liparidae. The dorsal gland on the seventh abdominal segment of Lycaenidae is also said to occur in all species but is so minute that it is usually overlooked. The ventral prothoracic glands of many noctuids, notodontians, and nymphalids are conspicuous enough but their occurrence does not usually depend upon family or generic limits.

Several kinds of processes of the body wall are less closely associated with setae than are scoli and verrucae. The most common of these are *cornicula,* or little horns, usually heavily chitinized. They are very often present on the suranal plate. A corniculum is similar to a chalaza in shape but does not bear a seta.

Certain slender fleshy processes have been given the name, ''fleshy filaments'', by former authors, and that term describes their structure so well that no further explanation is necessary. They vary from one to many pairs and are found in all Lymnadidae (Fig. 92) and in the papilionid genus Laertias.

Other projections of the body wall are described in connection with the larvae which bear them. *Gibbosities* are large round dorsal swellings more like malformations than processes. *Horns* are sharp pointed and unbranched, the caudal horn of the sphingids being the best example. *Protuberances* are large rounded swellings without definite outlines and are usually lateral in position.

There are two or more large chitinized plates covering the dorsal half of a segment. The first is the prothoracic shield (Figs. 7, 25, etc.), a thickening of the cuticula covering the greater part of the dorsal half of the prothorax. In a few cases shields are also developed on segments II and 9. The dorsum of segment 10 bears the suranal plate, which varies from a mere thickening of the body wall to a highly modified and variously specialized structure. (Fig. 84.)

A glossary giving all these terms will be found at the close of the paper. Following it, the method of numbering the segments is described and a list of the Greek letters used for setae is given.

CLASSIFICATION

In nomenclature Dyar's "List of North American Lepidoptera" (1902) has been followed throughout. While this list is not perfect, it is widely distributed and is the most accurate one now extant. In a few cases in which the genus has been divided since the publication of that list the new names are used but the old ones are included in parenthesis. Certain species have also been described since 1902 and they are the only ones for which the authority is given. Outside the Microlepidoptera, the only important change in the families is in the transference of Apatelodes from Notodontidae to Eupterotidae and in the rearrangement of the Saturnioidea.

It has been necessary to revise the Microlepidoptera entirely, owing to a rapid advance in our knowledge of the adults. The grouping and the division into families is principally a compilation from Walsingham and from published and unpublished work of August Busck. At the same time we believe that nothing in the larval structure precludes this arrangement and that it is a more natural classification than any published more than a decade ago.

The order of treatment is the reverse of that usually followed in Lepidoptera. There seems to be no excuse for beginning lists and outlines of this order with the most specialized forms when a treatment of Hymenoptera always starts with a consideration of the Tenthredinoidea, Coleoptera with the Carabidae, Diptera with the Nematocera, etc. The latter arrangement is the logical one and the most natural. For that reason families are listed here in an order which proceeds so far as possible from generalized to specialized. In most cases, consequently, it is the exact reverse of that followed in Dyar's List.

FAMILIES OF LEPIDOPTERA

a. Thoracic legs wanting or mere fleshy swellings.
  b. Body fleshy and swollen at middle, fusiform; front closed above. PRODOXIDAE
  bb. Body cylindrical or depressed, never fusiform.
    c. Head with ocelli of each side either six in number or reduced to one; front reaching vertical triangle.
      d. Head with all ocelli small, subequal in size.
        e. Abdominal segments 3, 4, 5, and 6 with rudimentary prolegs, each bearing several transverse bands of crochets. TISCHERIIDAE
        ee. Abdomen either without prolegs or crochets or with crochets on segments 3, 4, and 5. GRACILARIIDAE
      dd. Head with one large and conspicuous ocellus on each side.
        e. Ocelli cephalic, located close to lateral angles of clypeus; front triangular in outline. MICROPTERYGIDAE
        ee. Ocelli lateral, distant from lateral angles of clypeus; front quadrangular.
          f. Front wider at caudal end than at cephalic; body often depressed and moniliform; prolegs not as in the alternative. GRACILARIIDAE
          ff. Front narrower at caudal end than at cephalic; body always cylindrical; segments II and III and 2 to 7 bearing prolegs without crochets (Fig. 93). NEPTICULIDAE
    cc. Head with two conspicuous ocelli on each side; front not reaching vertex. HELIODINIDAE
aa. Thoracic legs present and segmented.
  b. Prolegs and crochets wholly wanting.
    c. Body fusiform; head small but not greatly depressed; front not extending to vertical triangle.
      d. Intersegmental incisions indistinct; scoli usually present; body colored; size large. COCHLIDIIDAE
      dd. Intersegmental incisions distinct; scoli never present; body pale; size very small.
        e. Kappa and eta distant or all setae wanting. PRODOXIDAE
        ee. Kappa and eta adjacent; setae small but distinct. GELECHIIDAE
    cc. Body usually cylindrical, always very small; head depressed but not narrowed; front extending to vertical triangle. COLEOPHORIDAE

bb. Prolegs always present, when reduced represented by at least rudimentary crochets.

c. Body bearing neither tufted nor secondary setae; prolegs not bearing more than four setae (pi, nu, tau, and sigma) (Fig. 101), except that there may be five when crochets are arranged in a multiserial circle; mu never a verruca, never associated with additional subprimaries.

d. Crochets never arranged in a pseudocircle (Fig. 97) or mesoseries (Fig. 105), usually in a circle (Fig. 101) or penellipse (Fig. 98) or transverse bands (Fig. 99); epsilon on prothorax always below alpha and gamma (Fig. 7).

e. Prolegs of sixth abdominal segment absent or without crochets; larvae small, leaf-miners. GRACILARIIDAE

ee. Prolegs of sixth abdominal segment as well developed as those of segments 3, 4, and 5.

f. Kappa group on prothorax bisetose, theta absent (Fig. 43); crochets never multiserial.

g. Crochets uniordinal, arranged in a complete circle; body cylindrical; Pi group on mesothorax unisetose. ORNEODIDAE

gg. Crochets biordinal (Figs. 98, 101), except when body is spindle-shaped and very fleshy and when Pi group on mesothorax is bisetose (Fig. 50). PYRALIDIDAE

ff. Kappa group on prothorax trisetose, theta present (Fig. 39).

g. Crochets arranged in transverse bands (Fig. 99).

h. Crochets arranged either in a single transverse row or in two multiserial bands on each proleg. INCURVARIIDAE

hh. Crochets always arranged in two uniserial bands on each proleg.

i. Kappa and eta of abdomen remote. BUCCULATRIGIDAE

ii. Kappa and eta of abdomen adjacent (Fig. 41).

j. Crochets of anal prolegs in two groups. GELECHIIDAE

jj. Crochets of anal prolegs in a single transverse row.

k. Front extending about one third of the distance to the vertical triangle. COSSIDAE

kk. Front extending at least two thirds of the distance to the vertical triangle.

l. Spiracles elliptical, normal in size, those of segment 8 farther dorsad than others. AEGERIIDAE

ll. Spiracles circular, very small, the pair of segment 8 about in line; crochets of right and left sides usually almost continuous across ventromeson. COLEOPHORIDAE

gg. Crochets arranged in a circle or penellipse.

h. Kappa and eta of abdomen remote or eta wanting (Fig. 8).

i. Crochets arranged in a multiserial circle (Fig. 96) or in a penellipse (Fig. 98).

j. Setae beta of prothorax closer together on dorsum than setae alpha; crochets always in a multiserial circle. ACROLOPHIDAE

jj. Setae beta on prothorax farther apart than setae alpha.

k. Theta absent on abdomen (Fig. 37); beta, delta, and rho distant on the prothorax (Fig. 35); crochets sometimes in a penellipse. YPONOMEUTIDAE

kk. Theta present on abdomen (Fig. 6); beta, delta, and rho adjacent on prothorax (Fig. 5). HEPIALIDAE

ii. Crochets arranged in a uniserial circle.

j. Prothorax with setae of Kappa group distant, about as far from spiracle as from each other; setae alpha of abdomen closer together than setae beta. LYONETIIDAE

jj. Prothorax with setae of Kappa group all close together, twice as far from spiracle as from each other.

k. Setae alpha of abdomen much farther apart on dorsum than setae beta. TINEIDAE

kk. Setae alpha of abdomen not farther apart on dorsum than setae beta. HELIODINIDAE

hh. Kappa and eta of abdomen adjacent (Fig. 41); crochets in a uniserial circle or penellipse.

i. Pi group of mesothorax bisetose (Fig. 36).

j. Long axis of prothoracic spiracle vertical; setae alpha of segment 9 closer together than setae beta. THYRIDIDAE jj. Long axis of prothoracic spiracle horizontal (Fig. 69). PSYCHIDAE

ii. Pi group on mesothorax unisetose (Fig. 40); setae alpha of segment 9 farther apart than setae beta.

j. Setae beta closer together on segment 9 than on any other abdominal segment, usually on the same or adjacent pinacula (Fig. 42). TORTRICIDAE

jj. Setae beta at least as far apart on segment 9 as on other abdominal segments, never borne on the same or adjacent pinacula (Fig. 56).

k. Mandibles large and conspicuous, extending far beyond margins of labrum (Fig. 72); larvae borers, in later instars very large. COSSIDAE

kk. Mandibles small, larvae leaf-feeders, always small.

l. Coxae of metathoracic legs twice as far apart as wide; setae indistinct, prolegs small. COSMOPTERYGIDAE

ll. Coxae of metathoracic legs never twice as far apart as wide.

m. Adfrontals reaching vertical triangle or nearly so; front extending two thirds of the distance to the vertical triangle, when shorter forming an attenuate point, or head not depressed, not held horizontally.

n. Crochets biordinal in most species; addomen with alpha and beta remote, segment 8 with rho never caudodorsad of spiracle.

o. Fourth ocellus much closer to third than to sixth, second closer to third than to first. OECOPHORIDAE*

oo. Third ocellus not so closely associated with second and fourth. GELECHIIDAE*

nn. Crochets uniordinal.

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*Characters separating these two families and the next not constant.

o. Abdomen with rho of segment 8 caudodorsad of spiracle, alpha and beta remote. BLASTOBASIDAE*

oo. Abdomen with rho of segment 8 dorsad or cephalodorsad of spiracle.

p. Alpha and beta of abdomen adjacent. (Schreckensteinia). YPONOMEUTIDAE

pp. Alpha and beta of abdomen remote. HEMEROPHILIDAE

mm. Adfrontals reaching about two thirds, front less than half, the distance to vertical triangle; front blunt at apex; head depressed, held horizontally. STENOMIDAE

dd. Crochets arranged in a pseudocircle (Fig. 97) or mesoseries (Figs. 100, 105).

e. Prothorax with Kappa group trisetose, and with epsilon below alpha and gamma, not near rho (Fig. 35).

f. Kappa and eta of abdomen remote; crochets uniordinal, sometimes arranged in a pseudocircle. YPONOMEUTIDAE

ff. Kappa and eta of abdomen adjacent; crochets arranged in a mesoseries.

g. Setae beta of prothorax about as far apart as setae alpha; prolegs usually short. ETHMIIDAE

gg. Setae beta of prothorax very much closer together than setae alpha; prolegs long and slender. HEMEROPHILIDAE

ee. Prothorax with Kappa group bisetose, and with epsilon associated with rho between delta and spiracle (Fig. 21); kappa and eta of abdomen remote; crochets arranged in a mesoseries, usually uniordinal.

f. Pi group on mesothorax and metathorax bisetose (Fig. 50).

g. Setae small, borne on minute papillae. THYATIRIDAE

gg. Setae well developed, borne on chalazae.

h. Chalazae rho of abdominal segments bisetose. LITHOSIIDAE

hh. Chalazae rho of abdomen unisetose (Utetheisa). ARCTIIDAE

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*Characters separating this and the two preceding families not constant.

ff. Pi group on mesothorax and metathorax unisetose (Fig. 22).
  g. Body without conspicuous gibbosities. NOCTUIDAE
  gg. Body with one or more distinct transverse dorsal gibbosities; coloration mainly in transverse stripes. {AGARISTIDAE NOCTUIDAE}

cc. Body bearing tufted or secondary setae or at least five setae on prolegs; mu usually associated with several other subprimaries (Figs. 59 to 68); crochets never arranged in a multiserial circle.
 d. Crochets uniordinal (Figs. 100, 105).
  e. Number of pairs of ventral prolegs three or six.
   f. Abdominal segments 2 to 7, inclusive, bearing prolegs, those of segments 2 and 7 without crochets; verrucae bearing large numbers of fine setae. MEGALOPYGIDAE
   ff. Abdominal segments 2, 3 and 7 not bearing prolegs; verrucae bearing few setae. NOLIDAE
  ee. Number of pairs of ventral prolegs four.
   f. Verrucae reduced, or obscured by development of secondary setae, or absent.
    g. Head muricate; ocelli on papillae, the third very large. AGAPETIDAE
    gg. Head smooth or nearly so; ocelli sessile, the third normal.
     h. Body very small, hemispherical in shape; head retractile, minute; habit parasitic; crochets uniordinal, arranged in a complete circle. EPIPYROPIDAE
     hh. Body cylindrical; habits not parasitic.
      i. Secondary setae numerous, often obscuring both primary setae and verrucae.
       j. Spiracles small, circular (Fig. 104); ventral prolegs long, slender (Fig. 95). PTEROPHORIDAE
       jj. Spiracles elliptical, well developed (Fig. 79); ventral prolegs short (Fig. 105).
        k. Notch of labrum deep, with parallel sides and rounded bottom (see footnote, p. —); body often bearing tufts and pencils of setae but never with cornicula. NOCTUIDAE
        kk. Notch of labrum acute, not with parallel sides; body never bearing tufts and pencils of

setae but sometimes with cornicula.
NOTODONTIDAE

ii. Secondary setae absent or sparse; primary setae always distinct, tho sometimes small.

j. Kappa at about the same level on abdominal segments 6, 7, and 8; setae very small; no humps, horns, or minute cuticular processes present. (Doa). ARCTIIDAE

jj. Kappa much lower on segment 7 than on segments 6 and 8 (Fig. 31).

k. Suranal plate terminating in an acute process and anal prolegs wanting (Fig. 89); crochets in a pseudocircle (Fig. 97).
PLATYPTERYGIDAE

kk. Suranal plate rounded posteriorly; crochets in a mesoseries.

l. Body covered with minute cuticular processes; form cylindrical except for a dorsal gibbosity on abdominal segment 8; no stemapoda or horns present.
DIOPTIDAE

ll. Body not covered with minute processes; horns, stemapoda, or gibbosities usually present. NOTODONTIDAE

ff. Verrucae (Fig. 88), at least mu, well developed, distinct, bearing many setae; secondary setae sparse or absent except on prolegs.

g. Eversible mediodorsal glands present on abdominal segments 6 and 7. LIPARIDAE

gg. Eversible dorsal glands wanting.

h. Spiracles large, elliptical (Fig. 79).

i. Verruca kappa in about the same position on abdominal segment 7 as on segments 6 and 8 (Figs. 33, 67, 68); when somewhat lower, mesothorax bearing only one verruca above the Kappa group.

j. Mesothorax bearing only one verruca above Kappa group on each side. SYNTOMIDAE

jj. Mesothorax bearing two verrucae above Kappa group on each side (Fig. 26). ARCTIIDAE

ii. Verruca kappa much lower in position on segment 7 than on segments 6 and 8, often absent or fused with verruca eta especially on segment 7 (Figs. 65, 66).

j. Crochets homoideous (Fig. 105); mesothorax bearing two verrucae above Kappa group; labrum with a deep, parallel-sided notch. NOCTUIDAE

jj. Crochets heteroideous (Fig. 100); mesothorax usually bearing only one verruca above Kappa group; verrucae conspicuous, altho without numerous setae. PERICOPIDAE

hh. Spiracles small, circular (Fig. 104).

i. Head small, retractile; prolegs short. PYROMORPHIDAE

ii. Head not retractile; prolegs long, slender, cylindrical (Fig. 95). PTEROPHORIDAE

dd. Crochets biordinal or triordinal (Figs. 102, 106).

e. Setae of body either primary or tufted, never numerous and secondary; several subprimaries present on venter or on prolegs, sometimes rather numerous when anal prolegs are wanting or ventral prolegs reduced in number (Fig. 63).

f. Crochets in a complete circle (Fig. 101).

g. Alpha and beta of abdomen in the form of verrucae. (Scythris). YPONOMEUTIDAE

gg. Alpha and beta of abdomen single setae; kappa and eta of abdomen adjacent. LACOSOMIDAE

ff. Crochets in a mesoseries (Fig. 106) or pseudocircle (Fig. 97).

g. Suranal plate terminating in an acute process and anal prolegs wanting (Fig. 89); crochets in a pseudocircle. PLATYPTERYGIDAE

gg. Suranal plate rounded caudad; anal prolegs present.

h. Number of pairs of ventral prolegs four, all well developed.

i. Kappa group on prothorax trisetose (Fig. 39); kappa and eta of abdomen adjacent. ETHMIIDAE

ii. Kappa group on prothorax bisetose (Fig. 43); kappa and eta distant, at least on abdominal segments 4 to 8.

j. Prothorax and abdominal segment 8 with spiracles twice as large as those of other segments. EPIPLEMIDAE jj. Prothorax and abdominal segment 8 with spiracles no larger than those of other segments. THYATIRIDAE

hh. Number of pairs of ventral prolegs reduced, cephalic three pairs rudimentary or wanting. GEOMETRIDAE

ee. Setae of body secondary, always numerous at least on prolegs; anal pair and four ventral pairs of prolegs always present.

f. Secondary setae very irregular in length, very long setae mixed with others a tenth as long; neither distinct verrucae nor scoli ever present; body often bearing lateroventral, blunt, fleshy protuberances.

g. Labrum deeply notched, notch acute, either reaching over two-thirds the length of the labrum or continued as a groove which reaches clypeus; several mediodorsal pencils of setae often present. EUPTEROTIDAE

gg. Labrum obtusely notched; notch variable but never reaching two-thirds distance to base of labrum, never continued as a groove which reaches clypeus. LASIOCAMPIDAE

ff. Secondary setae usually short and uniform in length; when long and irregular either distinct verrucae or scoli are present.

g. Body usually armed with a mediodorsal horn, scar, scolus, or pair of scoli on segment 8; if not, head produced into a high conical point; scoli never present on head nor on dorsomeson of segments 1 to 7; head smooth; crochets usually only biordinal.

h. Body sphingiform, never bearing even rudimentary scoli or secondary setae above level of prolegs.

i. Segments divided into six to eight annulets; prolegs not widely separated. SPHINGIDAE

ii. Segments not divided into annulets; prolegs widely separated. BOMBYCIDAE

hh. Body not sphingiform, always bearing at least rudimentary scoli. SATURNIOIDEA

gg. Body usually not armed with a mediodorsal horn, scar, scolus or pair of scoli on segment 8; when so armed, either segments 4 to 7 also bear unpaired mediodorsal scoli or the head is conspicuously bigibbous above, usually bearing a pair of scoli or pointed prominences; crochets usually triordinal.

h. Crochets arranged in a circle, usually triordinal, lateral crochets about as well developed as mesal; secondary setae small or absent on dorsal half of body, never long and never borne on scoli.
  i. Head much larger than prothorax; body largest at middle distinctly tapering toward both ends. HESPERIIDAE
  ii. Head partially retractile, smaller than prothorax; body cylindrical. MEGATHYMIDAE
hh. Crochets arranged in a mesoseries or pseudocircle, lateral crochets, when present, rudimentary; long setae and scoli sometimes present.
  i. Prolegs with mesoseries interrupted or reduced at middle and with a narrow spatulate fleshy lobe arising near the interruption (Fig. 102); head small.
    j. Head about half the diameter of the body. RIODINIDAE
    jj. Head usually less than half the diameter of the body. LYCAENIDAE
  ii. Prolegs without a fleshy lobe near the middle of the mesoseries.
    j. Osmaterium wanting.
      k. Scoli (Figs. 73, 74) or fleshy filaments (Fig. 92) well developed and conspicuous on body; when reduced, large scoli present on head.
        l. Mesothorax and sometimes a few other segments bearing fleshy filaments; secondary setae short and confined to prolegs. LYMNADIDAE
        ll. Fleshy filaments never present.
          m. Scoli at least twelve times as long as wide, those of abdomen as long as metathorax is wide; each abdominal segment bearing three scoli on each side, none on dorsomeson. HELICONIIDAE
          mm. Scoli when present not so slender; those of abdomen not as long as metathorax is wide; mediodorsal scoli usually present. NYMPHALIDAE

kk. Scoli never present on head or body; fleshy filaments never present.
  l. Suranal plate bifurcate at tip, bearing two distinct processes (Fig. 84). AGAPETIDAE
  ll. Suranal plate rounded, entire.
    m. Crochets in a pseudocircle (Fig. 97); setae never borne on chalazae; head small. LIBYTHEIDAE
    mm. Crochets in a mesoseries.
      n. Head conspicuously larger than prothorax. NYMPHALIDAE
      nn. Head not larger than prothorax; setae usually borne on chalazae. PIERIDAE

jj. Osmaterium present on prothorax; when retracted, presence shown by dorsal groove through which it is everted.
  k. Setae minute, never borne on verrucae except in early instars. PAPILIONIDAE
  kk. Setae well developed; some verrucae present. PARNASSIIDAE

SUBORDER JUGATAE

SUPERFAMILY MICROPTERYGOIDEA

The association of the Hepialidae with the Micropterygidae dates from Comstock's work on wing venation in 1893. Since that time they have usually been placed together in a separate suborder from all other moths and butterflies. There seem to be no larval structures, however, which unite the two families. Dyar (1895b) after studying both Micropteryx and Eriocephala, as well as Hepialus, concludes that, "there is nothing to contradict placing Micropteryx with Hepialus in the suborder Jugatae" and that "there seems to be nothing to preclude a derivation of Eriocephala from Micropteryx"; but these statements are hardly definite enough to convince one of the relationships of the genera in the absence of constructive evidence.

Family Hepialidae

The larvae of several European species of Hepialus will be found described in Part One. (See Figs. 2-6, 13, 14.) In addition it should be mentioned here that the ocelli are not in a semicircle but are in two vertical rows of three each and that the crochets of the ventral prolegs are in a complete multiserial circle, while those of the anal pair are similar but are nearly or quite interrupted caudally. Sthenopis is another American genus of this family but no larvae have been seen by the writer.

Family Micropterygidae

The larvae of only one species of this family have been examined. The setae are almost or entirely indistinguishable. Thoracic and abdominal legs are wholly wanting and the head is strongly depressed. The body is thickest at the prothorax and gradually diminishes posteriorly, the anal segment having a very small diameter. The front extends to the large vertical triangle. Close to the cephalic end of each arm of the epicranial suture is a single large ocellus.

Epimartyria auricrinella was the species seen.

SUBORDER FRENATAE

MICROLEPIDOPTERA

Altho much abused, the term Microlepidoptera is a convenient one to indicate the smaller members of the Heterocera. The limits of the group are not now and never can be fixed, for the division is not an entirely natural one. Used here to cover the same families that Dyar's List includes in "TINEOIDEA", it embraces three or more wholly separate groups, no more closely related to each other than some of them are to the Macrolepidoptera.

The following is an outline of the classification used in this paper. The sources from which it was drawn and the reasons for departing from Dyar's arrangement are given in the introduction to Part Two. It is followed by a brief discussion of the larval characters which bear on the relationships of the group.

A. Aculeata
        Nepticulidae
        Prodoxidae
        Incurvariidae
        Tischeriidae

B. Non-aculeata
    a. Tineoid series
        Tineoidea
            Acrolophidae
            Tineidae
            Bucculatrigidae
            Lyonetiidae
        Yponomeutoidea
            Heliodinidae
            Yponomeutidae
        Gracilariidae
        Tortricidae
        Thyrididae
        Aegeriidae
        Cossidae

- Psychidae
- Elachistidae
- Coleophoridae
- Gelechioidea
  - Ethmiidae
  - Stenomidae
  - Hemerophilidae
  - Gelechiidae
  - Oecophoridae
  - Blastobasidae
  - Cosmopterygidae

b. Pyrali-zygaenoid series
- Pyralidoidea
  - Pyralididae
  - Orneodidae
  - Pterophoridae
- Zygaenoidea
  - Chalcosidae
  - Pyromorphidae
  - Epipyropidae
  - Dalceridae
  - Megalopygidae
  - Cochlidiidae

Position uncertain
- Lacosomidae
- Nolidae

Aculeata. The four small families included here are so reduced in size and structure that a classification of them based on larvae would require special preparation and a special set of characters. It is probable that the tentorium will be found to yield important evidence on the relationships of the families to each other and to other leaf-miners, such as the Gracilariidae. In all the species the crochets are wanting or in rudimentary transverse bands. The arrangement of the setae seems in most cases to be indistinguishable. The group Aculeata is based, as yet, wholly on adult structure. While both adults and larvae are specialized by reduction, the presence of aculei, on which the group is based, is a generalized character. The larval structure of the various species is described on a later page.

Non-aculeata. This general term comprises all micros without aculei on the wings. On the basis of larval structure scarcely a single character unites them to each other. The most constant distinctions are in the chaetotaxy of the prothorax. On Pseudanaphora, as on Hepialus, the setae rho and epsilon are as far apart as alpha and beta or nearly so. In Aegeriidae, many Tortricidae and others, rho has migrated forward and has become associated with epsilon below alpha and gamma. One or the other of these two conditions is present in all the Micros. In Macrolepidoptera, on the other hand, epsilon has retreated caudad while rho retains its primitive position below beta and delta. This character, so far as I know, has no exceptions in those forms which bear primary setae only.

A definite and clear distinction is also found in the Kappa group in front of the prothoracic spiracle. In the Macros this group consists of two setae, kappa and eta, while all Micros except Pyralidoidea and Zygaenoidea have three, theta being added.

The crochets also furnish useful characters, varying greatly in the more generalized half of the order but being nearly always arranged in a mesoseries or pseudocircle in the more specialized moths and butterflies. Again the Zygaenoidea must be excepted.

A point to which Dyar called attention twenty years ago is the close relation of kappa and eta (''iv'' and ''v'') on the abdomen and this comes close to covering the Microlepidoptera as here limited. But apparently this was not the generalized condition at all. Nearly all Lepidoptera have descended from species which would now be included in the families Hepialidae, Micropterygidae, Acrolophidae, Tineidae, and Yponomeutidae, and yet all these families have kappa and eta separated, much as in Noctuidae.

The following seems to be the best explanation of the conflicting characters mentioned above:

The setae of the ancestor of all Non-aculeata were arranged very much as in Tineidae and Acrolophidae. (Figs. 7, 8, 15, 16.) Kappa on the prothorax was a trisetose group, epsilon was located below alpha and gamma and not associated with rho, kappa and eta on the abdomen were wholly distinct, and the crochets were in a complete circle, probably multiserial. Gradually evolution of this arrangement resulted in three main divisions, of which it is now impossible to tell which is the oldest.

One of these divisions (Figs. 39-42) retained theta on the prothorax, but, above the most generalized forms, kappa and eta became associated on the abdomen and all sorts of modifications took place in the development of crochets. In these forms epsilon keeps its original position while rho is likely to be found in any location back of it. The members of the Tineoid series possess this variable set of characters and are often honored with the name of ''true Micros'' in contradistinction to the pyralids and zygaenids.

A second group (Figs. 43-46) was distinguished by the loss of theta on the prothorax and the association of kappa and eta on the abdomen while epsilon remained below alpha and gamma on the prothorax and the crochets remained in a complete circle. The Pyralidoidea and probably the Zygaenoidea have originated from these forms and have retained all three distinctive characters except that the crochets have gradually been reduced in number and groups of adjacent setae have been modified into tufts.

In the third primary division (Figs. 21-24 et al.), theta was lost on the prothorax and epsilon migrated back to rho to cover the opening, kappa and eta remained distant on the abdomen, and the crochets became so limited in number as to reach less than half way round the proleg, forming a mesoseries. From this division have arisen all the true Macroheterocera, i. e., all the Macrolepidoptera except the Rhopalocera.

FAMILY NEPTICULIDAE

The immense number of species in the genus Nepticula causes one to hesitate to make generalizations concerning the family. Many of the larvae have been seen by entomologists, but very few species are familiar to the writer. Descriptions in most cases neglect to state whether legs are present on the thorax or crochets on the abdomen, whether the body is moniliform, depressed or cylindrical, and what is the shape of the front, altho they seldom fail to report whether the body is white or greenish white and that the head is brown.

In all the species of Nepticula examined, and in those described by Wood (1894), both crochets and segmented thoracic legs are wanting; there are two pairs of fleshy leglike swellings on the thoracic segments and six pairs on the abdomen (Fig. 93); the head is flattened but compressed rather than depressed; the front is narrowed caudad; the lobes of the epicranium extend caudad to a considerable distance behind the meeting point of the front and vertical triangle; and there is a single large and conspicuous ocellus on each side.

Ectoedemia obrutella, E. phleophaga, and *Opostega nonstrigella* were also examined and show a similar structure except that the proleglike swellings seem to be absent. A careful study of the entire head capsule and the tentorium will be necessary before these forms can be intelligently classified.

FAMILY PRODOXIDAE

The two well-known species of this family differ markedly, having but three or four readily observed characters in common. The head is not depressed as in many Aculeata, but is about as high as wide and is considerably smaller than the prothorax. The arms of the epicranial suture unite near the vertical triangle to form a stem which separates the front from the triangle. A third character is the lack of crochets, which seems strange in caterpillars of this size. The body is round and fleshy, and wider in the middle than at the ends.

Pronuba yuccasella possesses thoracic legs and swellings representing abdominal prolegs, the latter present on segments 3, 4, 5, and 6. These proleg swellings are not found on those Gelechiidae, Coleophoridae, and Cochlidiidae which are similar enough to cause confusion.

Prodoxus quinquepunctella is without legs or leglike swellings of any kind, but the closed front is sufficient to distinguish it from such other legless larvae as have the body similarly shaped. An undescribed species from agave in Arizona was also examined and was found to be very similar.

Family Incurvariidae

The larvae of this family are, in some respects, nearly as generalized as any members of the order. While it is perhaps an open question as to whether the common progenitor of Aculeata possessed a front which was closed above by the union of the arms of the epicranial suture or open to the vertical triangle, the conditions in other insects and in the Micropterygidae incline one to the former view. This would place Adela and Incurvaria closer to the common ancestor of all Frenatae than the Nepticulidae.

Head as high as broad, not retractile; front reaching about two-thirds of the distance to the vertical triangle; adfrontals extending to vertical triangle. Body cylindrical, intersegmental incisions shallow or indistinct; thorax with setae in the usual position but those dorsad of kappa indistinct; abdomen with kappa and eta adjacent, close to and caudad of ventral edge of spiracle; mu and Pi group as usual; thoracic legs present; prolegs indicated only by the crochets which are in transverse bands on segments 3, 4, 5, and 6.

Adela viridella and *A. degeerella* of Europe have the short and rudimentary crochets arranged in two transverse multiserial bands (Fig. 94). Forbes considers this condition to represent the beginning of crochets in Lepidoptera, but it is much more probable that such an arrangement is merely a reduced form of the multiserial circle found in Hepialus larvae. An unidentified American species from Vermont was also examined and in it the crochets were similar.

Incurvaria koerneriella has but one uniserial row of very rudimentary crochets to represent each proleg. This is undoubtedly a degenerate condition.

Family Tischeriidae

This family is a highly specialized group of Aculeata and its similarity to the Gracilariidae has usually caused it to be placed with them. The presence of crochets in the total absence of thoracic legs occurs only in these two families.

Head strongly depressed, three to six times as long as high; front extending to caudal margin of head, but usually narrowed caudad to a point; ocelli six in number, uniform in size. Body distinctly moniliform as seen from above, strongly depressed; thoracic legs wanting; abdominal segments 3, 4, 5, and 6 with each proleg represented by a pair of short, transverse, uniserial rows of very small uniordinal crochets.

Tischeria malifoliella, T. complanella, and other species of this genus are common blotch-miners. The front is wider at the caudal than at the cephalic end.

Coptotriche zelleriella is similar but less common. The front is narrowed caudad to a point.

SUPERFAMILY TINEOIDEA

It is with regret that this superfamily name is used, for the word may mean almost anything. But the group which includes Tinea must receive the above title, however ambiguous the word. In the sense employed here the superfamily includes less than half of the genera included by Dyar in Tineidae. The necessity for this change is explained in the introduction to the Microlepidoptera on a preceding page.

Characters of the larvae which show the relationship of the three families included here are: first, the trisetose Kappa group on the prothorax; second, the distance by which kappa and eta are separated on the abdomen; third, the triangular front which is not open dorsad; fourth, the location of beta on the prothorax, where it is closer to the dorsomeson than alpha.

Family Acrolophidae

The Acrolophidae, or Anaphorinae as they have been called, include some of the largest and most primitive of the Microlepidoptera. In addition to the structures common to the four tineoid families, Acrolophidae are differentiated by a multiserial circle of crochets (Fig. 96) and may be easily separated from Bucculatrigidae and Tineidae by the large size and the fact that kappa on the prothorax is more closely associated with theta near the spiracle than with eta in the more cephalic and more usual position (Fig. 7). *Pseudanaphora arcanella* was the only species examined.

FAMILY TINEIDAE

In this paper the Tineidae include only a few genera closely related to Tinea, such as Tineola and Scardia. They distinctly show the characters given for the superfamily Tineoidea but differ strikingly from the other three families in the following combination of characters: the setae alpha on the abdominal segments are farther apart than the setae beta, the crochets are uniordinal and are arranged in a complete uniserial circle, and the three setae forming the Kappa group on the prothorax are close together.

Scardia fiskeella (Figs. 51 to 54) was the only species examined of which the material was entirely satisfactory, altho *Tineola bisselliella* was also seen.

FAMILY BUCCULATRIGIDAE

Systematists have come to think of the genus Bucculatrix as a chronic obstacle to the satisfactory classification of the lower Micros. It has been driven ''from pillar to post'' and the end is not in sight. The situation usually consists in the positive denial of admittance to the particular family which an investigator is studying. The author erects a new family for the genus, first, because specialists on adult Microlepidoptera will not admit the validity of placing Bucculatrix in any one of the recognized families; second, because the larvae can not be closely associated with those of any other genus of which specimens have been examined. The diagnostic characters of *Bucculatrix koebelella* are as follows:

Head about as high as wide, not elongate, bearing primary setae only; front reaching about two-thirds, adfrontals all the way, to the vertical triangle. Body cylindrical, intersegmental incisions moderate. All setae in the position usual in Microlepidoptera, except that on the abdomen, kappa and eta are widely separated and at about the same level, and that alpha is below the level of beta on segments 8 and 9. Spiracles circular. Prolegs slender and rather long, present on segments 3, 4, 5, 6, and 10, the ventral ones each bearing two transverse bands of uniordinal, well-developed crochets, the anal pair bearing a single transverse band.

FAMILY LYONETIIDAE

The small size and generalized but obscure characters of this family make the genera and species difficult to distinguish. It is often almost impossible to make out locations of setae, arrangement of ocelli, and other points ordinarily of value.

Head more or less depressed; front triangular, not extending to vertical triangle in American species; boundaries of adfrontals extending to the vertical triangle on each side; first and second ocelli usually nearly contiguous, second, third, and sixth in a vertical row cephalad of the fifth. Body cylindrical, incisions moderate. Prothorax with the Kappa group trisetose, the three setae widely separated. Abdomen with alpha much closer to dorsomeson than beta, rho located immediately above spiracle, kappa some distance caudad of spiracle, and eta between kappa and spiracle but located farther ventrad, or in some cases apparently wanting. Thoracic legs present; prolegs present on segments 3, 4, 5, and 6, each bearing a complete uniserial circle of uniordinal crochets.

The above list of characters was drawn from specimens of *Bedellia somnulentella* and verified from *Proleucoptera smilaciella,* the only other American species seen. *Leucoptera (Cemiostoma) spartifoliella* of Europe differs from them in the front, which reaches the vertical triangle, and in the crochets, which are biserial in the caudal half of the circle.

SUPERFAMILY YPONOMEUTOIDEA

Still retaining the ancestral, generalized arrangement of setae, the few forms included in the Yponomeutoidea share with the Tineoidea the distinction of being closely similar to Hepialus and the primitive type. Altho a small group, the structure is extremely varied in those characters which, in specialized forms, are constant in entire superfamilies. There are two families each of which includes larvae of at least two strikingly different forms. Some authors consider Hemerophilidae and Ethmiidae as relatives of this group but the larval structure indicates a closer union with Gelechioidea. The same is true of the genus Schreckensteinia.

Family Heliodinidae

It is clear that the ''elachistid'' genera now included here are more closely related to Yponomeutidae than to any other families of the order. Kappa and eta of the abdomen are distant, the Kappa group of the prothorax is trisetose, with the three setae close together, and the front extends somewhat over half the distance to the vertical triangle in some species and reaches that triangle in others; the spiracle is small and circular.

Lithariapteryx abroniaeella. Head scarcely depressed; front short. Abdomen with kappa and eta not on the same swelling, alpha directly cephalad of beta. Crochets long, uniordinal or biordinal, arranged in a complete circle.

Antispila nyssaefoliella and *Aspidiscus* sp. (?). Head strongly depressed; front extending to vertical triangle; two pairs of ocelli large and conspicuous, the others reduced. Thoracic and abdominal legs wanting. Abdomen with kappa and eta distinctly separated but both on the same swelling.

FAMILY YPONOMEUTIDAE

Like the Pterophoridae this family is difficult to diagnose on account of the great variation among the different genera it includes. At the same time there is little or no overlapping with other families. All Yponomeutidae except Scythris and Schreckensteinia have beta below the level of alpha on the prothorax, the Kappa group trisetose on the prothorax, and kappa and eta distant on the abdomen. No other larvae possess this combination of characters. The Tineoidea are the closest and constitute the principal reason for introducing the alpha-beta character above. In view of this definite combination of setal characters and the great variation in other particulars no general description is given for the family.

Schreckensteinia in the larval stage seems to be more closely related to Gelechioidea than to Plutellinae, where the more recent authorities place it. In addition to the characters given in the following table this genus may be distinguished by the prolegs, which are long and slender and at the tip bear from four to six crochets in a circle.

The subfamilies may be separated as follows:

a. Prolegs longer than wide; crochets uniserial, either biordinal or uniordinal; Pi group on metathorax represented by a single seta. PLUTELLINAE

aa. Prolegs wider than long; crochets various.

  b. Body bearing numerous setae on verruca-like plates; Pi group consisting of four to eight setae on each abdominal segment. SCYTHRIDINAE

  bb. Body bearing primary setae only; Pi group never bearing more than two setae on thoracic or three on abdominal segments. YPONOMEUTINAE

Following are partial keys to the genera:

Plutellinae

a. Abdomen with kappa and eta remote, alpha and beta remote.

  b. Crochets arranged in a pseudocircle. *Plutella*

  bb. Crochets arranged in a mesoseries. *Cerostoma*

aa. Abdomen with kappa and eta adjacent, alpha and beta adjacent. *Schreckensteinia*

Scythridinae

a. Crochets biordinal, arranged in a complete uniserial circle. *Scythris*

Yponomeutinae

a. Pi group on metathorax consisting of two setae.
  b. Crochets arranged in a mesoseries. *Mieza*
  bb. Crochets arranged in a multiserial circle. *Atteva*
aa. Pi group on metathorax consisting of a single seta; crochets arranged in a multiserial circle.
  b. Cephalic seta of Kappa group on prothorax ventrad of the other two.
    c. Beta ventrad of alpha on metathorax; segment 9 with a dorsal shield bearing setae alpha, beta, rho, kappa, and eta. *Zelleria*
    cc. Beta caudad of alpha on metathorax. *Swammerdamia*
  bb. Cephalic seta of Kappa group on prothorax dorsad of the other two; beta caudoventrad of alpha on metathorax. *Yponomeuta*

The following species of Yponomeutidae were examined:

Plutella maculipennis
Schreckensteinia erythriella
Mieza igninix
Zelleria gracilariella
Cerostoma rubrella
Scythris magnatella
Atteva aurea
Swammerdamia pyrella (Europe)
Yponomeuta plumbella, Y. multipunctella

FAMILY GRACILARIIDAE

The gracilarians form one of the most definitely bounded families of the order. Whether examined in an early or a late instar, they are distinct from the larvae of other moths. This is true in spite of the fact that a complete change of structure takes place at the second or a later molt. Before this molt the mandibles are horizontal and wheel-shaped, and toothed like a buzz-saw. No such structure is known elsewhere. The distinctive feature of the later instars is the presence of but three pairs of ventral prolegs, located on segments 3, 4, and 5. It should be noted that where the number of prolegs is reduced in other families, as in some Noctuidae, Geometridae, and Nolidae, they are always present on segment 6 and are first lost on segment 3. The prolegs of gracilarian larvae are very short and are often not represented by swellings at all but their location is shown by suckers or by crochets which are arranged in various ways. Thoracic legs may be present or wanting. The setae are so minute that their position usually can not be determined satisfactorily.

Three subfamilies are recognized, of one of which specimens have not been available.

Gracilariinae. Head as high as wide, shape normal; front not reaching vertical triangle. Body cylindrical, intersegmental incisions shallow. Thoracic legs present; crochets of prolegs arranged in a lateral penellipse enclosing a transverse series, all uniordinal (Fig. 103). *Gracilaria consimilella, G. violacella,* and *Ornix geminatella* were examined; and Coriscium, the only other genus, is described as being similar.

Lithocolletinae. Head depressed, strongly narrowed cephalad; front with subparallel sides, extending to vertical triangle and often widest at caudal margin of head. Body depressed, moniliform. Thoracic legs present or wanting; ventral prolegs reduced, either bearing transverse rows of crochets or modified into suckers, present on segments 3, 4, and 5.

Lithocolletis hamadryadella, L. ostensackenella, Marmara salictella, M. fulgidella, and *Cameraria* sp. (?) were studied. In Marmara both thoracic legs and crochets are present, while in Cameraria neither could be identified. The individuals of Lithocolletis varied in this regard. It is to be noted that in many cases legs are acquired at the last molt and that a persistent study of all stages will be necessary before the different genera can be distinguished with any assurance of accuracy.

Family Tortricidae

The family of leaf-rolling caterpillars is a remarkably uniform and generalized one. Larval structure indicates rather close relationship with both Cossidae and Gelechioidea but is not to be relied upon, for all these groups are typical Microlepidoptera in most respects and may belong to wholly different but only slightly specialized stocks. Individual fluctuating variations are rather confusing in an attempt at classification but all specimens seen will trace to the family except an occasional aberrant one. Greater difficulties are met in working with the genera. For example, about twenty percent of codling moth larvae have mu of segment 9 located on the same pinaculum with kappa and eta and will therefore not trace to Cydia. The writer has not found absolutely constant characters to distinguish the genera of this family but hopes that the synopsis given here will suggest other and possibly better means of separation. The larvae are of sufficient economic importance to warrant the expenditure of considerable time in the study of their structure.

Head not depressed; front extending from one-fourth to three-fourths of the distance to the vertical triangle; adfrontals usually touching the vertical triangle; ocelli six, variously arranged, but the sixth always rather close to the fourth and fifth. Body cylindrical or submoniliform, sometimes depressed in early but rarely in later instars. Setae of thorax and abdomen as in Figs. 39 to 42 except as noted for particular genera; rho directly cephalad of spiracle on segment 8 except in a few rare cases. Spiracles broad-elliptical in outline, somewhat larger and farther dorsad on eighth than on preceding segments. Prolegs always present on segments 3, 4, 5, 6, and 10, first four pairs each bearing a complete circle of uniordinal or biordinal crochets.

It will be noted that the subfamily Olethreutinae (Grapholithinae) is not accepted here, as no larval characters were found to justify it. The genera included under this name probably do not form a natural group. The other two subfamilies may be distinguished as follows:

a. Abdomen with kappa and eta in a horizontal line or nearly so; segment 7 with Pi group unisetose; prothorax with delta close to and ventrocephalad of beta; crochets uniordinal, sessile, poorly developed. PHALONIINAE
aa. Abdomen with kappa and eta in a diagonal or vertical line; segment 7 with Pi group at least bisetose; prothorax with delta ventrad or ventrocaudad of beta, sometimes distant. TORTRICINAE

Genera of Tortricinae:

a. Segment 9 with alpha close to rho and usually situated on the same pinaculum with it, not associated with beta (Fig. 42).
  b. Mu absent on segment 9 (as in Fig. 56); setae located on black and heavily chitinized pinacula; crochets uniordinal. *Sciaphila*
  bb. Mu present on segment 9, usually associated with kappa and eta.
    c. Adfrontals extending all the way and front about two-thirds of the way to the vertical triangle.
      d. Arms of epicranial suture concave in dorsal third, meeting in an attenuate point.
        e. First abdominal segment with kappa and eta in a diagonal line; seventh, in a horizontal line (as in Fig. 45). *Thiodia*
        ee. First abdominal segment with kappa and eta in a nearly vertical line (as in Fig. 41); seventh, in a diagonal line.
          f. Mu on segment 9 located on the same pinaculum with kappa and eta (as in Fig. 46). *Tmetocera*
          (In part) *Exartema*
          ff. Mu usually not located on the same pinaculum with kappa and eta (Fig. 42). *Cydia*
      dd. Arms of epicranial suture straight in dorsal third, meeting in a regularly narrowed point. *Eucosma*

cc. Adfrontals extending two thirds and front about one half the distance to the vertical triangle. *Pseudogalleria*

aa. Segment 9 with alpha as distant from rho as from beta (as in Fig. 38) and with mu, kappa, and eta present on one pinaculum (as in Fig. 46).

- b. Pi group consisting of only two setae on abdominal segment 7 and often only one on segment 8. *Alceris*
- bb. Pi group trisetose on abdominal segment 7 and bisetose on segment 8.
  - c. Middle seta of trisetose Kappa group on prothorax dorsad of the other two. *Epagoge*
  - cc. Middle seta of Kappa group on prothorax ventrad of or in line with the other two.
    - d. Middle seta of Kappa group on prothorax at least three times as far from caudal as from cephalic seta.
      - e. Mesothorax and metathorax with Pi group bisetose (as in Fig. 50). *Archips* (a)
      - ee. Mesothorax and metathorax with Pi group unisetose (Fig. 40)
        - f. Second ocellus much farther from first than from third. (Fig. 80). *Platynota*, *Archips* (b)
        - ff. Second ocellus as close to first as to third (Fig. 71). *Ancylis*, *Olethreutes*, *Tortrix*, *Episimus*, *Cenopis*
    - dd. Middle seta of Kappa group on prothorax not more than twice as far from caudal as from cephalic seta.
      - e. Fourth ocellus much closer to third than to sixth and caudad of line joining third and sixth. *Ecdytolophia*
      - ee. Fourth ocellus about half way between third and sixth and in line with them. (Fig. 70). *Enarmonia*

Lord Walsingham in a recent volume of the Biologia Centrali-Americana changes to some extent the generic location of species in the Tortricidae. Three of his transfers are adopted here, the former genus names being included in parenthesis; but in several other instances, the change does not seem to be supported by the evidence of larval structure. The following were the species examined:

PHALONIINAE.
  Phalonia hilarana (Europe)
TORTRICINAE
  Sciaphila wahlbomiana (Europe)
  Thiodia arctostaphylana
  Exartema malana, E. exoletum
  Tmetocera ocellana
  Cydia pomonella, C. (Melissopus) latiferreanus, C. saltitans
  Eucosma pulsatillana, E. scudderiana, E. (Proteopteryx) willingana Kearf.
  Pseudogalleria inimicella
  Alceris minuta, A. hastiana, A. foliana, A. brittania Kearf.
  Epagoge sulphureana, E. caryae
  Archips (a) *cerasivorana, A. fervidana, A. parallela*
  Archips (b) *argyrospila, A. negundana, A. rosaceana*
  Platynota labiosana
  Olethreutes niveiguttana, O. (Eudemis) vacciniana
  Ancylis comptana, A. divisana, A. nubeculana
  Tortrix fumiferana, T. quercifoliana, T. citrana
  Episimus argutanus
  Cenopis directana Walk., *C. pettitana* Robsn.
  Ecdytolophia insiticiana
  Enarmonia caryana, E. nebritana, E. prunivora

FAMILY THYRIDIDAE.

Head smaller than prothorax, bearing primary setae only; ocelli six, arranged in a regular semicircle; labrum moderately emarginate; front reaching more than half way to vertical triangle. Body regularly cylindrical; intersegmental incisions shallow. Prothorax with a shield bearing rho near epsilon below alpha and gamma; Kappa group trisetose. Mesothorax and metathorax with Pi group bisetose. First eight abdominal segments with alpha farther laterad than beta, epsilon absent or very minute, kappa and eta borne on the same pinaculum, Pi group consisting of two setae on segment 1, three setae on segments 2 to 6, two setae on 7, one seta on 8; abdominal segment 9 with alpha closer to dorsomeson than beta (Fig. 55). Prolegs with biordinal crochets in a complete circle; anal prolegs with transverse series of crochets. Spiracles elliptical, small.

The above characterization was made from *Thyris fenestrella* of Europe and *Dysodia oculatana* of America, the chaetotaxy of the two being constant. The bisetose Pi group of the last two thoracic segments and the arrangement of the setae on segment 9 of the abdomen will distinguish this family from all others. The affinities are clearly with the true Microlepidoptera, not with the Zygaenoidea or Bombycoidea.

Thyris differs from Dysodia in the shape of the front, which in the former is nearly as broad as high, with adfrontals bounded by straight lines, while in Dysodia it is long and narrow with nearly parallel sides and the adfrontals are widened above.

Three other genera with unknown larvae are recorded from North America, in addition to Thyridopyralis. The latter does not belong in this family. As the name indicates, the imaginal characters conflict, but those of the larva clearly place *T. gallaerandalis,* the only species, in Pyralididae, subfamily Phycitinae. The pyralid structures are the bisetose Kappa group of the prothorax, the unisetose Pi group of the other thoracic segments, and the position of alpha on segment 9 where it is farther laterad than beta.

FAMILY AEGERIIDAE.

Sesiidae, the name used in Dyar's List for this family, is the one by which it is best known, but as it has been discarded in all the more recent systematic work, there seems to be no reason for continuing the error. It appears to be clearly established that Sesia belongs in Sphingidae and that Aegeria is the oldest genus in the family.

The larvae are well known borers and at least two of them are serious and very common enemies of the peach. All are so uniform that their separation is difficult. A key to the known species has been published by Dyar (Beutenmüller, 1900). The one given below is based on practically the same species but employs different characters, and it is hoped that later workers will add to the number of good generic distinctions as well as to the number of known larvae. The following characters are common to all the species:

Head smaller than prothorax, with strong mandibles; front and ocelli various; labrum shallowly concave at tip. Body cylindrical, incisions rather deep. Prothorax with beta farther mesad than alpha and with Kappa group trisetose, mesothorax and metathorax as in Tortricidae (Fig. 40). Abdomen with kappa and eta adjacent and other setae as usual except that they are disarranged on segment 8 by the change in the position of the spiracle; segment 9 with all setae in a single transverse row (Fig. 57). Spiracles broad and elliptical, much larger and higher on eighth than on other abdominal segments. Prolegs always bearing two transverse bands of uniordinal crochets (Fig. 99).

Genera of Aegeriidae:

a. The three caudodorsal ocelli forming a triangle with an acute angle at the second ocellus (Fig. 77); seta kappa on metathorax at least two and one-half times as far from eta as from theta.*

  b. Vertical triangle longer than wide, touching adfrontals. *Vespamima*

  bb. Vertical triangle broadly rounded, wider than long, usually not touching adfrontals.

    c. Crochets not more than nine in number, large and thick; setae large and distinct. *Parharmonia*

    cc. Crochets usually over ten in number, when fewer they are small and slender; setae reduced.

      d. Adfrontals uniform in width, sides straight or convex. *Sanninoidea**

      dd. Adfrontals strongly narrowed near frontal seta, margins sinuate, concave in part of their course. *Aegeria*

aa. The three caudodorsal ocelli forming a triangle always with an obtuse angle at the second ocellus (Fig. 75); seta kappa of metathorax never more than twice as far from eta as from theta.

  b. Spiracles of eighth abdominal segment located subdorsally, at least six times as far apart as each is wide; annulets distinct.

    c. Crochets fifteen to eighteen in a row; adfrontal margins touching vertical triangle. *Podosesia*

    cc. Crochets less than fifteen or more than eighteen in number; adfrontals usually not touching vertical triangle. *Memythrus*

  bb. Spiracles of segment 8 located on the dorsum, less than four times as far apart as each is wide; annulets indistinct; setae very small. *Melittia*

The following species were studied in arranging the above table:

Vespamima sequoiae
Parharmonia pini
Sanninoidea exitiosa, S. opalescens
Aegeria (Synanthedon) pictipes, A. rutilans, A. castaneae
Podosesia syringae
Memythrus polistiformis, M. robinae, M. tricinctus, M. brillians
Melittia satyriniformis

In addition, Dyar in the paper referred to above describes the following:

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*Each species of Sanninoidea differs somewhat from one or the other of the two characters included in "a"; both characters must therefore be tried.

Bembecia marginata. Crochets very small, ten to fifteen in a row; spiracles slightly chitinized; setae strongly developed; segments triannulate; adfrontals not reaching vertical triangle.

Alcathoe caudata. Similar to Bembecia except that the crochets are larger and are heavily chitinized.

FAMILY COSSIDAE.

The Carpenter moths received their popular name from the larval habit of boring in trees. This form of life has modified the structure, especially of the head, and has caused the development of rather heavily chitinized pinacula for relatively reduced setae. Many of the species attain considerable size and their larvae are some of our largest caterpillars.

Head broad, usually longer, if not higher, than wide, smaller than prothorax to which it is closely united; front varying from one third to one half height of head; dorsal four ocelli forming nearly a semicircle distant from the fourth and fifth; labrum truncate at tip, with a scarcely perceptible emargination; mandibles very large. (Fig. 72.) Body widest at prothorax, narrowest at beginning of abdomen, bearing primary setae only. Prothorax with rho directly caudad of epsilon, Kappa group trisetose. Mesothorax and metathorax as in Tortricidae (Fig. 40). Abdomen with kappa and eta adjacent; epsilon usually present cephalad of spiracle, sometimes large; beta above level of alpha on segment 9. Prolegs present on segment 3, 4, 5, 6, and 10; crochets various.

Genera of Cossidae:

a. Crochets uniordinal, arranged in two transverse bands; prothorax bearing a large, dorsal, semicircular, rugose plate on its caudal half; spiracles of segment 8 two or three times as large as those of segments 1 to 7 and located much nearer dorsomeson. *Cossula*
aa. Crochets biordinal or triordinal, arranged in a complete circle.
  b. Prothoracic shield with the caudal margin smooth and not elevated; spiracle of segment 8 in line with those of segments 1 to 7, below rho.
    c. Setae alpha of middle abdominal segments only two-thirds as far apart on dorsum as setae beta. *Prionoxystus*
    cc. Setae alpha of middle abdominal segments more than three-fourths as far apart as setae beta (in American species). *Cossus*
  bb. Prothoracic shield with the dorsal half of the caudal margin conspicuous and strongly rugose; spiracle of segment 8 higher than those of segments 1 to 7, caudad of rho. *Zeuzera*

Cossula magnifica is so different from other cossid larvae that at first it seems to deserve the rank of a separate subfamily. Certain European larvae form a series connecting this type with the others, hence such a division could not be defended. For example, in *Phragmatoecia castaneae* Hübner, the crochets are uniordinal but arranged in a complete circle and the last pair of spiracles are enlarged and moved dorsad as in *Cossula; Dyspessa ulula* Borkh. has rudimentary crochets in indefinite transverse rows but all the spiracles are in line.

Prionoxystus robiniae is our most common species. The larva, which bores in locust and other trees, often reaches a length of three inches. *P. macmurtrei,* the only other species, is smaller and bores in a number of different trees. The crochets of the latter species are circular in arrangement while those of the former are in a very narrow ellipse.

Cossus centerensis has a larval structure nearly identical with that of Prionoxystus. The two are hard to distinguish and the character given in the table does not hold for European species of Cossus. There is a Rocky Mountain species, the larva of which I have not seen.

Zeuzera pyrina has a world-wide distribution. Like *Cossula magnifica,* it is distinct from the other forms and is the only species of the genus found in North America.

Larvae of the western genus Hypopta and the subtropical Inguromorpha have not been seen.

Family Psychidae

The Bagworm moths are a peculiar group which Dyar at one time considered as deserving the erection of a separate suborder. He seems later to have abandoned this view, which was based on the fact that alpha and beta are located on the same annulet of the abdominal segments instead of on successive ones. The homology seems clear enough altho the position of the setae is, it is true, different from that found in other larvae. This combined with the absolutely unique horizontal prothoracic spiracle shows that the family is an ancient one. The different genera are remarkably uniform.

Head overarched by the prothorax above but large and not truly retractile; front and adfrontals various; labrum notched to about half its depth; ocelli normal. Body with primary setae only, these very minute in later stages. Prothorax with all setae normal, Kappa group trisetose, epsilon and rho distant from each other; mesothorax and metathorax normal except that the Pi group is bisetose. Abdomen with alpha, beta, and rho in almost a straight line above the spiracle, but alpha and beta close together on segment 9; kappa and eta adjacent; mu present; Pi group normal. Prolegs present as usual on segments 3, 4, 5, 6, and 10, the crochets arranged in the same uniordinal, lateral penellipse on the anal as on the ventral pairs (Fig. 85). Spiracles elliptical, the prothoracic pair much larger than those of the abdomen and placed horizontally (Fig. 69).

While the body setae offer some characters of taxonomic importance in separating the genera, I hesitate to use them on account of their great reduction. In many cases it is impossible to find them without a prolonged search. This is not true, however, of the head setae, whose location is distinct. The fact that their position varies with the different genera is fortunate, for the coloration and general shape of the body are too constant to aid in identification.

In the following synopsis the division into Solenobiinae and Psychinae is retained and some new facts are added to the characters Forbes used in their separation. With one exception his larvae were of different species from the ones mentioned below.

Genera of Psychidae:

a. Second adfrontal seta much farther dorsad than frontal seta, first adfrontal seta above level of top of front (Fig. 83); thoracic legs with last two segments very slender; alpha of abdomen above level of beta. (Solenobiinae.) *Solenobia*

aa. Second adfrontal seta very close to frontal seta, first adfrontal seta below level of top of front (Figs. 76, 79, 82); thoracic legs with last two segments stout; alpha of abdomen below level of beta. (Psychinae.)

  b. Margins of adfrontals meeting dorsad at an acute angle, adfrontals scarcely widened above first adfrontal seta (Fig. 76); larvae small, pale, not exceeding two centimeters in length. *Eurycittarus*

  bb. Margins of adfrontals meeting dorsad at a very obtuse angle or in a horizontal line; larvae three to five centimeters in length in last stage, usually dark in color.

    c. Frontal seta located below line connecting second adfrontal seta with frontal puncture (Fig. 78). *Thyridopteryx*

    cc. Frontal seta located above line connecting second adfrontal seta with frontal puncture (Fig. 82). *Oiketicus*

The following species were studied: *Solenobia walshella, Eurycittarus confederata, Thyridopteryx ephemeraeformis,* and *Oiketicus abbotii.* All are approximately unicolorous except for a tendency to longitudinal light and dark stripes on the thorax, especially on the dorsal half. Two other species, *Platoecticus gloveri* of Florida and *Chalia rileyi* of the ''Atlantic States'' are found east of the Rockies but they are rather rare and their larvae, so far as I know, have not been recognized.

Family Elachistidae

The Tineidae and Elachistidae have long been dumping grounds for all manner of Microlepidoptera. It is within the last five or six years (1909) that Busck has pointed out the necessity of dividing and redividing these ''families''. The Elachistidae appear to contain six well defined groups, five in addition to those related to Elachista. These are now known as Cycnidioidea, Coleophoridae, Cosmopterygidae, Heliodinidae, and Scythridinae of Yponomeutidae. Larvae of the true Elachistidae and of the superfamily Cycnidioidea have not been examined. Scythridinae and Heliodinidae are discussed in their proper place in the Yponomeutoidea. Cosmopterygidae will be found under Gelechioidea while Coleophoridae apparently do not belong in any of the superfamilies listed in this paper.

Family Coleophoridae

Head scarcely depressed; front extending about two-thirds, adfrontals all the way to the vertical triangle; ocelli all close together, seta vii closest to second ocellus, fourth ocellus usually as close to sixth as to fifth. Body cylindrical, setae almost indistinguishable, apparently in the normal microlepidopterous arrangement. Thoracic legs about as far apart as the width of the coxae; ventral prolegs each bearing two transverse uniserial bands of uniordinal crochets, usually so close to ventromeson that the bands of the right and left sides are nearly continuous with each other; anal prolegs each with a single transverse row close to ventromeson. Crochets reduced in number in some species, either rudimentary and reduced from two to six for each proleg as in *Coleophora fletcherella,* or entirely wanting as in *C. limospenella.* Spiracles small, circular, those of the eighth abdominal segment twice as large and slightly farther dorsad than those of other segments.

The following species of Coleophora were seen, all of them having transverse rows of crochets except as noted above: *tiliaefoliella, atriplicivora, fletcherella, gallipenella, ochripenella, limospenella,* and several others unidentified.

SUPERFAMILY GELECHIOIDEA

This group includes the most highly specialized of the tineoid series of Microlepidoptera. Some of the families are difficult to separate in any stage, especially as Gelechia seems to be rather a generalized genus from which several others diverged. The characters are such that the interrelations of the families can not be worked out from them altho there are a sufficient number of differences to separate them more or less completely from each other.

FAMILY ETHMIIDAE

This family was named and described in 1909 by Busck to accommodate the genus Ethmia, hitherto included in Oecophoridae. The new family was based wholly on characters of the adult, hence it is a striking fact that the larvae of Ethmia are distinctly different from those of any of the other genera usually associated with it. Unfortunately the larvae of but two species, *E. zelleriella* and *E. longimaculella,* were available, but their characters are important enough to make the following record of them desirable.

Head smaller than prothorax, bearing primary setae only; front with dorsal half of lateral margins straight; adfrontals not reaching vertical triangle; labrum moderately emarginate at tip; ocelli six, the fourth, fifth, and sixth forming a triangle with an acute angle at the fourth, the fourth farther from the fifth than from the sixth. Prothorax with alpha slightly closer to dorsomeson than beta, other setae in usual positions; mesothorax and metathorax normal. Abdomen with alpha above level of beta, rho dorsad of spiracle on segments 1 to 7, cephalad on segment 8, kappa and eta adjacent, mu present, Pi group various, sigma present. Prolegs short, with an extended *mesoseries* of biordinal crochets. Spiracles elliptical, slightly larger on segment 8 but no higher on body.

In *Ethmia zelleriella* the Pi group of the abdominal segments is trisetose as usual, while in *E. longimaculella* the number is increased to eight or ten setae. In neither species, however, is there any increase of setae on the thorax.

FAMILY STENOMIDAE

Recent study has shown that moths belonging to the genera Stenoma, Brachiloma, and Ide do not belong to the Australian family Xyloristidae where they were formerly placed, but constitute a separate group. According to Busck the three genera should be united under the name Stenoma.

Head rather broad and depressed, the mouth parts directed cephalad; front extending less than half way to vertex, and adfrontals little farther; labrum distinctly but not deeply emarginate; ocelli six; primary setae only. Body depressed, the spiracles somewhat below the middle of the lateral aspect. Prothorax with rho near epsilon below gamma, and the Kappa group trisetose; other two thoracic segments with Pi group unisetose. Abdomen with kappa and eta adjacent, beta farther laterad than alpha except on segment 8 where they are at about the same level, and segment 9 where it is farther mesad; kappa, eta, and mu on segment 9 located on the same pinaculum. Thoracic legs adjacent, prolegs short, each bearing a complete circle of biordinal crochets; anal prolegs bearing a single series of crochets on the cephalic margin.

Stenoma humilis has a small head, uniform in color and less than one-third the diameter of the body, while in *S. schlaegeri* and *S. brillians* Busck the head is about two-thirds the width of the body and is transversely striped, the stripe continuous in the former but broken and dotted in the latter.

Gonioterma albanum of Europe differs from the American species in that the Kappa group on segments 7 and 8 is cephalo-ventrad of rho while in Stenoma it is directly ventrad.

Family Hemerophilidae

Several important differences may be noted, distinguishing the larvae of this family from those of the Yponomeutidae, in which they have long been included. The most important is the close association of kappa and eta on the abdomen and the relative position of alpha and beta on the prothorax.

Head longer than wide; front much longer than wide, acute at caudal end, extending more than half way to vertical triangle; adfrontals narrow; ocelli all close together. Prothorax with alpha farther laterad than beta, rho distant from epsilon, Kappa group trisetose, and Pi group unisetose as usual; metathorax similar. Abdomen with spiracles round or broadly elliptical, beta farther laterad than alpha on all segments except 9, where alpha is usually much farther from dorsomeson; kappa and eta adjacent. Prolegs long and slender, with either a complete circle or mesoseries of uniordinal crochets, often poorly developed.

Four of the genera belonging to this family have been examined in the larval stage.

Choreutis leucobasis. Crochets rudimentary, arranged in a complete circle; Pi group on segments 2, 7, and 8 trisetose; all setae poorly developed; alpha and beta at about the same level on abdominal segments.

Allonyma (Hemerophila) vicarilis. Crochets strongly chitinized; setae well developed and borne on distinct pinacula; otherwise similar to Choreutis.

Brenthia pavonacella. Crochets in a complete circle; beta almost directly ventrad of alpha on abdominal segments 1 to 8, caudad of alpha on segment 9.

Trichostibas parvula Edwards. Crochets in a mesoseries; beta caudad of alpha on abdominal segments 1 to 8, dorsocaudad of alpha on segment 9; Pi group unisetose on segments 2, 7, and 8.

FAMILY GELECHIIDAE

The enumeration of Gelechiidae in Dyar's List is considered as very nearly correct and will be followed more closely than is possible with most other families of Microlepidoptera. Larvae of this family will be most often confused with Pyralididae and Tortricidae on account of similarity in size and habit. The distinctly trisetose Kappa group of the prothorax will differentiate from the former and the distance of setae beta on segment 9 will distinguish from the latter. It seems unnecessary to enumerate such characters as the location of all the setae, for the larvae are typical Micros, any important differences from the usual plan (Figs. 39-42) being noted in the tables. It might be mentioned in addition that the crochets are biordinal except in a few degenerate cases, that the front and adfrontals are very acute above, the adfrontals often reaching the vertical triangle, that the spiracles are circular in outline, those of segment 8 usually being larger and higher on the body, and that the ocelli are almost never arranged as described for Oecophoridae (cf. Figs. 80 and 81).

The following synopsis of the genera is incomplete, owing partially to lack of material, but is an arrangement which can be developed further as the larvae of more species become known.

a. Crochets wanting or reduced and rudimentary; no proleg swellings present; thoracic legs small.
  b. Body swollen and strongly tapering at ends. *Metzneria*
  bb. Body nearly cylindrical, scarcely tapering. *Sitotroga*
aa. Crochets present and well developed.
  b. Crochets of ventral prolegs in a complete circle, usually biordinal; those of anal prolegs in a continuous transverse series.
    c. Prolegs long and slender; crochets few; setae rudimentary; head retractile. *Nealyda*
    cc. Prolegs short and stout, crochets usually numerous.
      d. Setae rho of segment 8 cephalad, rarely cephalodorsad of spiracle; body always striped; setae large.
        e. Abdominal segment 7 with setae beta closer together on dorsum than setae alpha; segment 8 with setae beta farther apart than setae alpha. *Arogalea*
        ee. Segments 7 and 8 both with setae beta farther apart than setae alpha.

f. Triangle formed by the three cephaloventral ocelli having a right or obtuse angle at the fourth ocellus, the fifth as close to the fourth as to the sixth; coloration consisting wholly of transverse stripes. *Telphusa*

ff. Triangle formed by the three cephaloventral ocelli always having an acute angle at the fourth ocellus, the fifth about equidistant from the fourth and sixth; coloration almost always including longitudinal stripes. *Gelechia*
Recurvaria

dd. Seta rho of segment 8 dorsad, rarely cephalodorsad, of spiracle; body caudad of prothorax entirely pale; setae minute.

e. Head and prothorax usually strongly chitinized and black. *Phthorimaea*

ee. Head and prothorax slightly chitinized and pale. *Gnorimoschema*

bb. Crochets of ventral prolegs in a pair of transverse bands, usually biordinal, those of anal prolegs in two groups, prolegs short; spiracle of abdominal segment 8 very large. *Ypsolophus*
Anarsia
Trichotaphe
Anacampsis

The species of Gelechia vary greatly.

The difference between Gnorimoschema and Phthorimaea, as given, is certainly not one of generic value but may serve to separate the two species studied. It is unlikely that the collector east of the Mississippi will find larvae belonging to other species. According to Busck the two genera should be united.

The following species were studied, in most cases two to six individuals being seen. The variation is a serious problem only in the genus Gelechia.

Metzneria lapella
Sitotroga cerealella
Nealyda bifidella
Arogalea (Paralechia) cristifasciella
Telphusa fuscopunctella
Recurvaria sp. (?)
Phthorimaea operculella
Gnorimoschema gallaesolidaginis
Trichotaphe serrativatella, T. alacella
Anarsia lineatella
Ypsolophus ligulellus
Anacampsis populella, A. lagunculariella, A. innocuella

Gelechia trialbamaculella, G. cercerisella, G. hibiscella, G. unctulella, G. maculimarginella, G. pseudacaciella, and *G. serotinella* of North America, and *G. atriplicella, G. acuminatella, G. rhombella,* and *G. mulinella* of Europe.

FAMILY OECOPHORIDAE

This is one of the families formerly included in Gelechiidae and the larvae are so similar to the latter that no satisfactory character has been found to distinguish the two groups. They seem to divide along the same lines on the basis of the position of rho on segment 8 of the abdomen. In all the species seen the adfrontals extend to the vertical triangle, the prolegs are short and stout and bear a complete circle of biordinal crochets and the prothoracic shield is lightly chitinized. The fourth ocellus is always much closer to the third than to the sixth, and the second is always farther from the first than from the third. Otherwise the characters are the same as in Gelechiidae.

Depressaria is the best known genus in the family. As a rule the setae are located on heavily chitinized pinacula, often elevated and chalaza-like; kappa and eta of the abdomen are borne on a small pinaculum directly ventrad of rho, eta being located cephalodorsad of kappa on the first two or three abdominal segments; rho on segment 8 is always a little above the level of the top of the spiracle, tho located farther cephalad on the segment. *Depressaria heracliana* and *D. cinereocostella* of America and *D. depressella* of Europe were seen.

Agonopteryx Hübner has recently been separated from *Depressaria* altho the difference between the two is very slight in any stage. This genus agrees with all the characters given in the preceding paragraph except that eta is cephaloventrad of kappa on the first two or three abdominal segments. The species examined were *A. umbraticostella, A. lythrella,* and *A. posticella,* all of North America.

Machimia tentoriferella is a larva with indistinct and slightly chitinized setae and with obscure or absent pinacula; rho on segment 8 is cephalad of the spiracle and at the same level; kappa and eta are below the spiracle and located farther caudad than rho.

Psilocorsis quercicella and *P. obsoletella,* formerly included in *Cryptolechia,* are closely related to the other two genera mentioned and their characters indicate an intermediate position. The pinacula are distinct, rho on segment 8 is directly cephalad of the spiracle and kappa and eta are on a pinaculum ventrad of rho.

Oecophora similella, Dasystoma salicella, and *Chimabache fagella,* of Europe, are similar in all important particulars to the American forms.

Family Blastobasidae

The larvae of this family are very similar to the last two discussed but a few differences remain. Rho, on abdominal segment 8, is caudodorsad of the spiracle, while kappa is cephaloventrad, an arrangement found in no other larvae. The prolegs are short and bear a complete series of uniordinal crochets, which are, however, sometimes irregular. Only primary setae are present on the body. Ocelli indefinite in specimens examined.

The species seen were: *Valentinia glandulella* Riley and *Holcocera gigantella* Ch. of North America and *Endrosis lacteella* of Europe.

Family Cosmopterygidae

Head more or less depressed, very much so in *Cosmopteryx,* small, retractile within prothorax; adfrontals not quite reaching vertical triangle; ocelli all close together, seta vii closest to second ocellus, fourth ocellus usually as close to sixth as to fifth. Setae of body small; abdomen with kappa and eta adjacent; setae beta of segment 9 much farther apart than each is from alpha of that side, beta, alpha, and rho in a transverse line. Thoracic legs with coxae twice as far apart as wide; prolegs far apart, each bearing a complete circle of uniordinal *(Stilbosis)* or biordinal crochets.

The following species were examined:
Cosmopteryx gemmiferella, C. clandestinella,
Limnoecia phragmitiella,
Homaledra sobalella, H. heptathalama, and
Stilbosis tesquella, of America, and
Cosmopteryx scribalella,
Heydenia fulvigutella, and
Laverna phragmitella of Europe.

SUPERFAMILY PYRALIDOIDEA

Scarcely half a dozen characters are common to all the larvae within this superfamily. The deciding factors are the presence of a bisetose Kappa group on the prothorax and the close association of kappa and eta on the abdomen. Some of the Pterophoridae have these points obscured by secondary and tufted setae, and such incidental structures as the circular spiracles and the long slender prolegs must be used in determination. (Figs. 47, 48, 61.)

Unless care is taken in observing the number of setae on the prolegs, *Lacosoma* will trace to this superfamily. It is distinguished from Pyralidoidea by the Pi group which consists of from four to eight setae.

FAMILY PYRALIDIDAE

The superfamily character of a bisetose Kappa group on the prothorax, combined with the presence of short prolegs bearing either a pair of transverse bands or a more or less complete circle of biordinal crochets, limits the family. In some specimens of *Galleria mellonella* the crochets seem to be uniordinal but no individuals have been seen in which that was true of all the prolegs.

The family includes four main divisions typified by the following four subfamilies: Chrysauginae, Galleriinae, Phycitinae, and Pyraustinae. The species of the first two are few in number while each of the others is very large in addition to being associated with several smaller subfamilies. The structural basis of these divisions is shown by the following synopsis:

a. Crochets uniordinal, arranged in two transverse bands; front extending nearly and adfrontals entirely to vertical triangle. CHRYSAUGINAE
aa. Crochets arranged in a pseudocircle or penellipse, very rarely uniordinal.
  b. Pi group on mesothorax and metathorax bisetose; crochets sometimes uniordinal (Fig. 50). GALLERIINAE
  bb. Pi group on mesothorax and metathorax unisetose; crochets always biordinal or triordinal.
    c. Kappa and mu present on segment 9, usually associated with eta on the same pinaculum (Fig. 46); crochets arranged in a complete circle. EPIPASCHIINAE, PYRALIDINAE, PHYCITINAE
    cc. Kappa and mu absent or extremely minute on segment 9, eta well developed, not associated with other setae (Fig. 49).
      d. Crochets arranged in a penellipse.
        e. Crochets biordinal. (In part) CRAMBINAE
        ee. Crochets triordinal (Fig. 98). PYRAUSTINAE
      dd. Crochets arranged in a complete circle.
        e. Crochets triordinal. (In part) CRAMBINAE
        ee. Crochets biordinal. (See also subfamily descriptions.) NYMPHULINAE, SCOPARIINAE

Chrysauginae. This subfamily must have been separated from other pyralids at a rather remote period in their history, for intermediate stages are lost and the differences, especially in the crochets, are striking. The chaetotaxy is as in the other subfamilies but it may be noted that the Pi group on the mesothorax and metathorax is unisetose, that alpha on segment 9 is about as far from rho as from beta, and that kappa, eta, and mu are present and subequal in size, but not closely associated with each other. The species examined was *Clydonopteron (Salobrana) tecomae.*

Galleriinae. Aside from their peculiar habits as pests of beehives, these larvae are easy to recognize by distinctive structures as well. The Pi group on the last two thoracic segments is bisetose; the two setae of the Kappa group on the prothorax as well as the abdomen are nearly in a horizontal line instead of a vertical one as usual; the crochets are either biordinal or uniordinal, never triordinal, and are arranged in a complete circle; alpha, beta, and rho on segment 9 form an equilateral triangle, rho being directly ventrad of beta.

Two species were examined. In *Galleria mellonella (=cereana)* the body is thickened in the middle and tapering towards both ends and the coxae of the metathoracic legs are twice as far apart as wide. In *Achroia grisella* the body is cylindrical and the thoracic legs are close together.

Epipaschiinae. This small group is a closely circumscribed one with characters which associate it with Phycitinae. A few of the latter show nearly all the peculiarities of this subfamily, so Epipaschiinae are introduced into the table for the separation of the genera of Phycitinae instead of being separated from them in the synopsis of the subfamilies. The crochets are triordinal, the longest about four times the length of the shortest. Other characters are given in the synopsis of Phycitinae.

The following species were examined: *Epipaschia superatalis, E. zelleri, Jocara perseella* B. & McD., *Tetralopha militella, T. floridella,* and *T. robustella.*

Pyralidinae. While the structure of the three species of Pyralidinae* examined is quite constant, it is almost impossible to find a character which will distinguish them from Phycitinae as a whole. They will be found in the table of genera of the latter group. In *Pyralis farinalis* the crochets are biordinal, the shorter ones about one-fourth the length of the others (Fig. 101), but those of *Omphalocera dentosa* and *O. cariosa* are as in the two related subfamilies. In all three species beta is clearly in the caudad row of the setae on the prothoracic shield and is scarcely farther cephalad than delta; the third and fourth ocelli are close together and the fourth out of line; the front extends about half way to vertical triangle and the adfrontals about two-thirds; and the head is about as broad as long. In color *Pyralis* is pale while the species of *Omphalocera* are dark with white pinacula.

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*The larva of *Hypsopygia costalis,* examined since writing the above, agrees with Pyralis with respect to the prolegs, and will trace near to this genus in the key.

Phycitinae. This group and Pyraustinae are the two large subfamilies of Pyralididae and many of the larvae of both of them are of economic importance. They represent two diverging lines of evolution, the one characterized by a complete circle of crochets on the prolegs and the presence of kappa and mu on segment 9, the other losing the lateral crochets of the prolegs as well as kappa and mu on segment 9. Associated with Phycitinae in the former division are the two subfamilies just discussed, and all three are included together in a single synopsis of the genera, those belonging to Pyralidinae being marked with an asterisk (*).

Genera of Phycitinae, Pyralinae, and Epipaschiinae:

a. Prothorax with delta twice as far caudad of beta as beta is of alpha, alpha and beta usually closely associated (Fig. 47).
  b. Head longer than broad; body unicolorous, dark. *Thyridopyralis*
  bb. Head broader than long.
    c. Boundaries of adfrontals meeting epicranial suture at a point nearly twice as far from vertical triangle as from front; coloration in longitudinal stripes. *Meroptera*
    cc. Boundaries of adfrontals meeting epicranial suture at a point half way between vertical triangle and front.
      d. Kappa nearly directly caudad of eta on first abdominal segment; fourth ocellus about as close to sixth as to third. *Euzophera*
      dd. Kappa directly dorsad of eta on first abdominal segment; fourth ocellus farther from sixth than from third.
        e. Pinacula of all setae heavily chitinized; body widened at middle. *Melitara*
        ee. Pinacula of all setae slightly chitinized; body cylindrical. *Salebria*
aa. Prothorax with delta much less than twice as far caudad of beta as beta is of alpha, beta and delta often closely associated (Fig. 43).
  b. Beta of prothorax nearly directly dorsad of delta; head and body pale (Fig. 43). *Psorosina*
  bb. Beta of prothorax located much farther cephalad than delta.
    c. Boundaries of adfrontals reaching vertical triangle.
      d. Vertical triangle nearly as large as front; prothoracic shield black. *Elasmopalpus*
      dd. Vertical triangle normal, small; prothoracic shield pale; pinacula slightly chitinized. *Hulstea*
    cc. Boundaries of adfrontals not reaching vertical triangle.
      d. Kappa of first abdominal segment directly dorsad of eta; boundaries of adfrontals meeting in an acute point.

e. Three ventral ocelli not forming an equilateral triangle, angle at sixth ocellus right or obtuse (Fig. 71).

f. Front extending about two-thirds of the distance to vertical triangle; adfrontals meeting epicranial suture about half way between front and vertical triangle. *Plodia*

ff. Front extending about half way to vertical triangle.

g. Boundaries of adfrontals meeting epicranial suture about half way between front and vertical triangle; crochets biordinal, the longer four times the length of the shorter (Fig. 101). *Pyralis**

gg. Boundaries of adfrontals meeting epicranial suture at a point about twice as far from the vertical triangle as from front; crochets triordinal. *Ephestia*
Vitula

ee. Three ventral ocelli forming an equilateral triangle, acute angle at each ocellus (Fig. 70); front reaching about half way to vertical triangle.

f. Head rugose; body dark. *Acrobasis*

ff. Head smooth. *Mineola* (a)

dd. Kappa of first abdominal segment directly caudad of eta or nearly so; front extending about half way to vertical triangle.

e. Second ocellus not closer to third than to first; body not striped.

f. Lateral margins of adfrontals convex dorsad, meeting in an obtuse angle; body dark, not spotted. *Tacoma*

ff. Lateral margins of adfrontals nearly straight, meeting in an acute angle.

g. Body and pinacula pale. *Canarsia*
Mineola (b)

gg. Body black with white pinacula. *Omphalocera**

ee. Second ocellus much closer to third than to first; first ocellus larger than others; lateral margins of front very convex; body striped, usually longitudinally. (See subfamily.) EPIPASCHIINAE

The following species of Phycitinae were examined:

Thyridopyralis gallaerandalis (heretofore included in Thyrididae)
Meroptera pravella
Euzophera ostricolorella
Salebria contatella
Elasmopalpus lignosellus
Plodia interpunctella
Melitara prodenialis
Psorosina (Canarsia) hammondi
Hulstea undulatella
Ephestia kuehniella, E. cautella

Vitula edmandsii
Mineola indiginella (a)
  M. amplexella (b)
Tacoma nyssaecolella
Acrobasis betulella
  A. comptoniella
  A. stigmella Dyar
Canarsia ulmiarrosorella

Crambinae. The larvae of many species of Crambus are of economic importance and should be familiar to entomologists. They can not readily be differentiated from each other, but can be distinguished from other groups. Any larva with a complete circle of triordinal crochets, with but two setae in front of the prothoracic spiracle, with a single seta on segment 9 caudad of the spiracle on segment 8 and with but one seta at the base of each mesothoracic leg, is a crambid. In addition there are a few species which closely resemble Pyraustinae. *Crambus trisectus, Chilo prejadellus,* and *Dicymolomia julianalis,* together with a large number of unidentified species of Crambus, were examined.

Pyraustinae. The penellipse of crochets which characterizes this subfamily varies in extent from a semicircle to an almost complete ellipse. Other subfamilies are entirely distinct, except a few Crambinae, most of which have biordinal crochets.

Genera of Pyraustinae:

a. Front extending three-fourths, adfrontals nearly or all the way, to the vertical triangle.
  b. Kappa on eighth abdominal segment located directly dorsad of eta; first ocellus much larger than others. *Hellula*
  bb. Kappa on eighth abdominal segment located caudodorsad of eta; first ocellus not much larger than others.
    c. Adfrontals not strongly widened above, their lateral margins rather regularly convergent; head normal in size.
      d. Head not bilobed above, except slightly in some species.
        e. Spiracles elliptical in outline, heavily chitinized, normal in size; body with black pinacula and sometimes black stripes. *Loxostege*
        ee. Spiracles circular in outline, slightly chitinized, very small; body decorated with transverse red stripes. *Eustixia*
      dd. Head conspicuously bilobed above, with the epicranial suture forming a deep groove between the lobes; head black, body marked with conspicuous black and white spots. *Tholeria*
    cc. Adfrontals strongly widened above so that their lateral boundaries appear to be parallel to each other for the ventral three-fourths of their length; head very small. *Cybalomia*

aa. Front extending less than two-thirds of the distance to vertical triangle*; adfrontals not reaching vertical triangle; ocelli subequal in size.
  b. Rho on eighth abdominal segment directly dorsad of spiracle. *Hymenia*
  bb. Rho on eighth abdominal segment cephalodorsad of top of spiracle.
    c. Second ocellus about half way between first and third; seta vii usually closest to second ocellus; penellipse more than a semicircle.
      d. Front with sides straight or concave.
        e. Alpha and rho on ninth abdominal segment in a horizontal line; head not depressed; labrum with a rounded emargination. *Pachyzancla*
        ee. Alpha and rho on ninth abdominal segment not in a horizontal line, except in some species in which the labrum has an acute notch.
          f. Head very much depressed; labrum with an acute notch. *Desmia*
          ff. Head not depressed; labrum usually not with an acute notch.
            g. Pinacula heavily chitinized, black. *Pyrausta*
            gg. Pinacula slightly chitinized, pale. *Phlyctaenia*
      dd. Front with sides rather convex throughout their entire length; seta vii closest to third ocellus.
        e. Adfrontals conspicuously widened above the front. *Sylepta*
        ee. Adfrontals not widened above the front. *Terastia*
    cc. Second ocellus much closer to first than to third; seta vii closest to third ocellus; penellipse less than a semicircle.
      d. Setae alpha of first abdominal segment more than twice as far apart as each is from beta; body bearing subdorsal longitudinal stripes or dotted areas; subdorsal pinacula heavily chitinized. *Evergestis*
      dd. Setae alpha of first abdominal segment not more than one and a half times as far apart as each is from beta.
        e. Alpha directly dorsad of rho on eighth abdominal segment.
          f. Labrum very broad and short, shallowly but acutely emarginate; head spotted. *Dichogama*
          ff. Labrum normal, with a rounded emargination; head unicolorous.
            g. Thoracic legs and abdominal prolegs short and often stout.

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*Except sometimes in *Evergestis* which may fall in "a".

h. Head compressed, retractile, one and a half times as long as prothorax. *Diaphania*

hh. Head not compressed, not noticeably retractile, smaller than prothorax. *Asciodes*

gg. Thoracic legs and abdominal prolegs long and slender; head not compressed, not greater than prothorax in height.

h. Head higher than broad; body pale. *Pantographa*

hh. Head broader than high; body marked with black spots. *Epicorsia*

ee. Alpha located much farther cephalad than rho on eighth abdominal segment. *Paradosis*

The following species were examined:

Hellula undalis
Phlyctaenia extricalis
  P. tertialis
Eustixia pupula
Cybalomia belialis
Pachyzancla bipunctalis
Pyrausta penitalis
  P. cingulata
  P. thestealis
Dichogama redtenbacheri
Diaphania nitidalis
  D. quadristigmalis
  D. sibillalis
Paradosis flegia
Loxostege sticticalis
  L. mancalis
  L. maclurae
Tholeria reversalis
Hymenia perspectalis
Desmia funeralis
Sylepta fluctuosalis
Terastia meticulosalis
Evergestis dyaralis
  E. rimosalis
Asciodes gordialis
Pantographa limata
Epicorsia mellinalis

Nymphulinae. All the aquatic Pyralidoidea of America are included in this subfamily. The resulting structural modifications cause some difficulty in studying the chaetotaxy of the larvae. The few species with tracheal gills are easily identified, for no other insects possess both gills and prolegs with crochets.

Alpha is located near rho but the relative position of the two varies in different genera. Elophila and Nymphula differ from Scopariinae and Crambinae in the fact that the setae beta on segment 9 are three times as far apart as each is from alpha of that side, alpha being nearly in a direct line between beta and rho and close to each of them. On the other hand Geschna has the setae beta located near the dorsomeson as usual but differs from other Pyralidoidea in the position of alpha, which is directly cephalad of and close to rho. The kappa group on segment 9 is rather difficult to locate in this subfamily. The species examined were:

Nymphula obscuralis, N. obliteralis,
Geschna (Nymphula) cannalis
Elophila lemnata

Scopariinae. No American species of this subfamily have been seen. *Scoparia crataegella* has kappa and eta of the prothorax forming a vertical line; kappa and eta of the abdomen forming a horizontal line; alpha of segment 9 close to and cephalodorsad of rho; beta of segment 9 close to dorsomeson and located farther caudad than alpha and rho; kappa and mu absent from this segment; crochets biordinal, not triordinal, in a complete circle. Otherwise similar to Crambinae.

FAMILY ORNEODIDAE

Head mainly horizontal in position, smaller than prothorax, smooth; front extending about two-thirds of the distance to the vertical triangle; adfrontals indistinct; first five ocelli arranged in an arc, with the sixth behind the fifth; no secondary setae present. Body pale, bearing primary setae only; shape cylindrical; intersegmental incisions moderate. Prothorax with alpha, gamma and epsilon in a transverse row, beta and delta normal and rho behind and slightly below level of epsilon; Kappa group bisetose; Pi group bisetose; mesothorax with kappa closer to eta than to theta, otherwise normal. Abdomen with alpha above level of beta, rho dorsad of spiracle, kappa and eta adjacent, mu present; Pi group consisting of one seta on segments 1, 7, and 8 and of three setae on segments 2 to 6 inclusive; segments 9 and 10 damaged in material examined. Spiracles circular, slightly larger on prothorax than on other segments, located farther dorsad on segment 8 than on segments 1 to 7. Prolegs short, present on segments 3, 4, 5, and 6, bearing a complete circle of uniordinal crochets.

The family contains but one species, *Orneodes hexadactyla.* It will be seen from the description that the structure is essentially that of a pyralid, being distinguished from all other micros, except some Pterophoridae, by the bisetose Kappa group of the prothorax. Galleria is the only genus of Pyralididae which ever has uniordinal crochets and in it the body is fusiform, the size large, and the Pi group on the mesothorax is bisetose.

FAMILY PTEROPHORIDAE

Variations in the characters of the Plume-moth larvae are so numerous that some difficulty may be met with in placing some of the species. In practice, however, one soon learns to know the long, stem-like prolegs, regardless of the number of setae or crochets. (See Fig. 61.) No other caterpillars possessing verrucae and secondary setae have prolegs of this shape, altho a few lower micros with primary setae show similar structures. All of the latter, however, have a trisetose Kappa group on the prothorax while that of the Pterophoridae is bisetose as in other Pyralidoidea. The species examined were *Pterophorus elliottii, Oxyptilus periscelidactylus, Platyptilia cosmodactyla* of America, and *Pterophorus microdactylus* and *Platyptilia rhododactylus* of Europe. In all of these verrucae are developed, except in *Pterophorus microdactylus* where the setae are as in Pyralididae.

SUPERFAMILY ZYGAENOIDEA

We begin the discussion of this superfamily with forms which have reached the point of the appearance of well developed verrucae and mesoserial crochets. The verrucae later become more strongly modified and the crochets peculiarly specialized. Another step and the crochets are wholly lost, while the armature includes forms of scoli found in no other larvae. The end of the process is seen in such a slug caterpillar as *Prolimacodes,* with the head minute and completely retracted, and the body smooth and almost spherical, bearing no processes of any kind except three pairs of minute thoracic legs.

No larvae of the families Chalcosidae and Dalceridae have been seen.

Family Pyromorphidae

Pyromorphid larvae form one of the earliest steps in the evolution of a typical Micro into a slug caterpillar. The Pterophoridae include the most plausible connecting links to the generalized types. The following characters show the close relation to Megalopygidae:

Head small, retractile, caudal half slightly chitinized; labrum with a small emargination; ocelli all similar in size, the fifth not set as far caudad of the fourth as in most caterpillars; primary setae only. Body cylindrical, with large flat verrucae. Prothorax with numerous setae on cervical shield, verruca of the Kappa group large; mesothorax and metathorax each with the verrucae of the Kappa group and of the Pi group forming single verrucae and with three verrucae dorsad of them on each side. Abdomen (Fig. 59) with verruca alpha fused with beta, and rho and the verruca of the Kappa group well developed; mu present; Pi group consisting of one or two verrucae. Prolegs present on segments 3, 4, 5, 6, and 10, each with crochets in a uniordinal mesoseries.

Triprocris is a western genus ranging from Mexico to Colorado and including eight species. *T. smithsonianus,* the one examined, has a large subventral eversible gland or fleshy protuberance on the prothorax associated with Pi, and two verrucae, the smaller cephalad of the larger, present between the proleg and the verruca of the Kappa group on abdominal segments 2 to 6; there is also a similar pair of verrucae on segment 7 but none on 8. The dorsomeson is marked by a dark line.

Harrisina and Acoloithus have the prothoracic protuberance but there is only one verruca between that of the Kappa group and the proleg on segments 2 to 6 and none on 7 or 8. *Harrisina americana* is rather common in the eastern states, feeding on grape and Virginia Creeper. The larva is pale except for the dark reddish verrucae. *H. metallica* of Texas and Arizona has a broad dark red lateral line running just above the spiracle, and transverse intersegmental stripes. The otherwise pale body of *H. brillians,* from the same region, is gaily decked with two broad reddish transverse stripes, the cephalic covering parts of the last thoracic and first two abdominal segments and the caudal extending from the verrucae of the sixth abdominal segment to those of the seventh. In addition the prothorax, mesothorax, and fourth and eighth abdominal segments bear narrow transverse vittae.

Acoloithus falsarius is pale, but obscurely dotted above. Other species of *Acoloithus* and *Harrisina* are very similar in the larval stage. The adults in this division of the family will have to be studied more carefully before the larvae can be correctly placed. Apparently some of the species have dimorphic larvae.

The larva of *Pyromorpha dimidiata* is dull, dark-colored. The prothorax does not bear a subventral protuberance; the verruca mu is present on the first seven abdominal segments but is not associated with a second verruca as in Triprocris.

FAMILY EPIPYROPIDAE.

The two species of this family, one Asiatic, *Epipyrops anomala,* and one American, *E. barberiana,* are anomalous caterpillars with a parasitic habit. The body is in the form of a depressed hemisphere, the head retractile within the first segments. Both thoracic and abdominal legs are present, the claws of the former being peculiar in that they bear a long tooth at the base. The crochets are in a complete circle and, altho uniordinal, are slightly irregular in position and length, their form being degenerate. Secondary setae are sparsely scattered over the entire body. The small head, stout body, and secondary setae indicate an affinity with the Zygaenoidea but reduction has taken a different direction than in Cochlidiidae. There is no sign of verrucae and the crochets are in a complete circle, an arrangement lost even in the Pyromorphidae.

FAMILY MEGALOPYGIDAE.

This family forms one of the important links in the Zygaenoidea, standing between the Zygaenidae themselves and the Cochlidiidae. Its members are particularly interesting as transition forms and their structure is the clue to the peculiarities of the slug caterpillars.

Head and cephalic part of prothorax retractile; head very small, slightly chitinized caudad of the fork of the epicranial suture; epicranium marked by a transverse line between apical and occipital areas, the former more heavily chitinized; labrum with a small mesal emargination; fourth and fifth ocelli much larger than others, sixth ocellus at a distance from first five; head setae sparse and slender.

Body thickened in the middle, small at the ends, fusiform; verrucae large but flat. Prothorax with one large verruca dorsad of spiracle, one small one (Kappa) in front of it, and two (Pi) at base of leg; mesothorax with three verrucae, Beta group, rho, and epsilon, above that of the Kappa group, Beta the largest; two verrucae forming Pi group at base of leg; metathorax with only two verrucae above that of the Kappa group, epsilon and rho being fused; otherwise similar to mesothorax. Abdomen with verrucae alpha and beta coalesced, kappa and eta coalesced; Pi group consisting of one verruca on segment 1 and of three around the base of each of the six pairs of ventral prolegs. Spiracles all circular, those of prothorax largest. Prolegs present on segments 2 to 7 and 10, those on 3, 4, 5, 6 bearing uniordinal crochets in two groups, cephalic group the smaller; these two groups form an angulated mesoseries in most cases but in one genus they are distinctly separated.

Carama cretata. Fifth ocellus as far from fourth as from first; two groups of crochets distinctly separated; verrucae each consisting of a thick group of short stiff setae and a few long slender ones.

Lagoa crispata has the fifth ocellus close to the fourth, the two groups of crochets contiguous and the verrucae each consisting of a few stiff setae and a great many slender ones. All the setae are subequal in length.

Megalopyge opercularis has the fifth ocellus rather distant from the fourth and the crochets and verrucae as in Lagoa. The dorsal setae of the ninth and tenth abdominal segments, however, are twice as long as those of the first eight segments and form a conspicuous tail.

FAMILY COCHLIDIIDAE.

In tables it is rather difficult to separate the slug caterpillars from the larvae of other Holometabola, but in nature the thick, short, fleshy body and the minute thoracic legs will distinguish these forms from all others. It should be remembered that there are no prolegs but that the thoracic legs are always present. The different genera seem to have little in common except the small retractile form of head. The armature has developed from verrucae, altho it often includes scolus-like structures. Some of the genera are entirely smooth.

A synopsis of the American species of this family is given as the conclusion of a series of papers by Dyar in 1899. It will be found in Jour. N. Y. Ent. Soc. 8, 1899, p. 235.

FAMILY LACOSOMIDAE.

Head rugose, wider than prothorax and much higher, with vertex on same level as dorsum of body but with ventral portion produced as far as the thoracic legs are long; ocelli all rather close together; labrum with a small notch; no secondary setae. Body widest at proleg-bearing segments, sometimes fusiform. Prothorax with epsilon below alpha and gamma, rho moved forward to a position near it; Kappa group bisetose. Mesothorax as usual. Alpha of abdomen nearer dorsomeson than beta on segments 1 to 9; kappa and eta adjacent; Pi group consisting of two to three setae on segments 1 and 2, four to eight setae on each proleg; two setae on segments 7 and 8, and one seta on segment 9. Prolegs present on segments 3 to 6 and 10, each of the five pairs bearing a biordinal complete circle of crochets.

Cicinnus melsheimeri has seta iv of the head enlarged and spatulate, its base as large as an ocellus; each proleg has six to eight setae on its cephalolateral surface; the anal segment is depressed; and the body is much thicker in the middle than at the ends.

Lacosoma chiridota has seta iv of the head normal, its base much smaller than an ocellus; each proleg bears four setae on its cephalolateral surface; the anal segment is scarcely depressed and the body is only slightly thickened in the proleg region. *L. arizonica* has not been seen.

FAMILY NOLIDAE.

Systematists differ greatly in placing this family. Hampson, in 1900, makes Nolinae one of the subfamilies of Arctiidae, which he considers the highest family of the entire order. A few years later Dyar includes the group in his Tineoidea, close to Cochlidiidae, Megalopygidae, etc. The latter position is based on the presence of but one verruca (Kappa) between Rho and mu, caudoventrad of the spiracle on the abdomen (Fig. 60), it being assumed that this verruca arose from a coalescence of kappa and eta. As many Acronyctinae have verruca kappa reduced to a single seta or even absent (Figs. 65 and 66) this condition does not seem sufficient to prove conclusively the position of the group.

Head smooth, smaller than prothorax, partially retractile, bearing primary setae only; front wider than high, not reaching half way to vertical triangle; labrum notched to about one-third its depth; sixth ocellus usually at a considerable distance from upper five which are in a semicircle enclosing seta vii; seta v rather closely associated with first ocellus (Fig. 86). Body cylindrical, bearing verrucae but no secondary setae except on prolegs. Prothorax with a large shield on which the dorsal verrucae are united; mesothorax bearing four verrucae on each side in a transverse row. Abdomen with the verrucae of the Beta, Rho, and Kappa groups present on the first nine segments; in addition segments 1, 2, 3, and 7 have mu and Pi in the form of small verrucae, and sigma a single seta; segments 4, 5, and 6 (Fig. 60) possess mu, but the setae of the Pi group are scattered over the proleg and united with sigma; on segments 8 and 9 mu is wanting but Pi is present. Prolegs are present on segments 4, 5, 6, and 10, only; crochets always biordinal, in a mesoseries.

The various species differ in the development of the verrucae, the positions of the ocelli, and the coloration. Owing to lack of material it is not possible to diagnose genera at the present time, especially as the differences which do exist overlap generic limits. The ocellar groups of two species are shown in Figs. 86 and 87.

MACROHETEROCERA

SUPERFAMILY BOMBYCOIDEA

Family Epiplemidae

Head about as high as wide, slightly bigibbous, usually minutely rugose; front extending about half way to vertical triangle; labrum moderately emarginate; no secondary setae. Prothorax bearing a dorsal plate with the setae in the usual positions, epsilon cephaloventrad of rho above spiracle; Kappa and Pi groups each consisting of two setae; mesothorax and metathorax normal. Abdomen (Fig. 62) with kappa and eta at about the same level below the spiracle, close together on segments 1 to 3, farther apart on segments 4 to 8; mu always associated with lambda, an additional subprimary; Pi group represented by one seta on segment 1, two setae on segment 2, four setae on the prolegs of segments 3 to 6, and one seta on segments 7 to 9; segment 9 with alpha below level of beta and as far from it as from rho, Kappa and Pi groups each represented by one seta. Prolegs with the planta semicircular, the band of crochets so curved as to be similar to a penellipse, crochets biordinal. Spiracles elliptical, those of the prothorax and abdominal segment 8 twice as high and wide as those of the other abdominal segments.

Four genera of this family are found in North America, only two of them occurring east of the Rocky Mountains. In *Callizzia inornata,* setae rho, kappa, and eta on segment 8 are about twice as far from the enlarged spiracle of that segment as the spiracle is high, and the coloration consists principally of a dark band through the setae rho, shading off to lighter brown above; the ventral half of the body is pale; the head is smooth and shining. In *Calledapteryx dryopterata,* setae rho, kappa, and eta are all closer to the spiracle than the spiracle is high, the coloration is paler and more indefinite, and the head is often coarsely rugose.

Family Geometridae.

Limits of time and space forbid a discussion of the ''loopers'' or ''inch-worms''. There seems to be sufficient variation in the armature, setae, and number and position of prolegs to warrant the belief that a separation of the genera is possible. As no other family has the prolegs of any of its members reduced to two pairs, one ventral and one anal, no difficulty need be encountered in placing the great majority of the species in the proper family. The additional rudimentary prolegs of Brephos, Anisopteryx, and a few other genera are likely to cause confusion. The larvae of this family are distinguished by the following characters, some of them possessed by other families, but when taken together, completely diagnostic of the Geometridae.

Body usually slender and cylindrical but sometimes bearing humps, processes, and protuberances of various kinds and shapes; only primary setae present above the level of the spiracle, but below eta subprimaries always found, varying in number from one, lambda, to many, covering the lateral half of the proleg. Prolegs of abdominal segments 3, 4, and 5 absent or, in a few cases, rudimentary; crochets biordinal, arranged in a mesoseries. (Fig. 63.)

FAMILY PLATYPTERYGIDAE.

Head about as high as wide, obscurely bigibbous; no secondary setae present. Prothorax with epsilon and rho much farther cephalad than in most Macrolepidoptera, Kappa group consisting of two setae. Pi group usually consisting of several setae borne on a lateral fleshy protuberance; mesothorax with all setae above spiracular level normal; below eta five or six setae are present in various arrangements, usually two on a level with mu of the abdomen and several in a group at the base of the leg forming the Pi group; metathorax similar. Abdomen with alpha and beta separate, epsilon and rho separate dorsad of spiracle, kappa caudad of spiracle, and eta below; mu present; three setae at base of proleg and three more on its lateral surface; segment 9 various. Setae usually borne on small chalazae, with great variation on ventral half of body, tho never very numerous. Prolegs of segments 3 to 6 with the planta circular, the crochets biordinal or uniordinal, arranged in a pseudocircle (Fig. 97), with the mesoseries extending about half way round the proleg, the lateral series shorter, with smaller crochets, not continuous with the mesoseries; anal prolegs wanting. Suranal plate terminating in an acute process (Fig. 89). Spiracles elliptical, those of prothorax about twice as large as those of abdominal segments.

The genera, representatives of all four of which are in the U. S. National Museum, may be distinguished by the various shapes and sizes of the processes bearing the setae.

Eudeilinea. Metathorax cylindrical, smooth above; head not bicornute; crochets uniordinal. The family Auzatidae, including in America only the single species of this genus, *E. herminiata,* is considered distinct from Platypterygidae in Comstock's ''Manual for the Study of Insects.'' The absence of a chalaza from the metathorax of the larvae and the lack of secondary setae seem strongly to favor this view.

Falcaria. This contains the single species, *F.bilineata.* It has a pair of chalazae on the mesothorax, another on the metathorax, and another on the second abdominal segment. The Pi group on the prothorax is borne on a conspicuous protuberance, about as long as the thoracic legs. The setae beta of segment 9 are closer together than setae alpha.

Drepana. Chalazae as in Falcaria. Prothoracic protuberance not as long as the thoracic legs. The setae beta on segment 9 are farther apart than setae alpha. *D. arcuata* from the eastern states is dark red above and bears a pair of dorsal chalazae on the first abdominal segment. *D. siculifer* from the Pacific coast is paler and segment 1 is without chalazae.

Oreta. Metathorax bearing a single corniculum on dorsomeson Head prominently bicornute. *Oreta rosea* was the only species examined.

Family Bombycidae.

Bombyx mori, the only species of the Bombycidae in North America, shows considerable resemblance to a sphingid but scarcely any similarity to the Saturnioidea, with which it is often placed. The setae are so reduced as to be of little value in identification. The caudal horn is present. Other characters are given in the table for the separation of families.

Family Lasiocampidae.

The larvae of the lasiocampids are usually made conspicuous by their large size, long setae and bright colors. They are common leaf-eating caterpillars and some do considerable damage. The number of setae over the entire head and body makes technical description and location in tables difficult.

Head smaller than body, often retractile, usually depressed; secondary setae numerous on all parts; labrum notched in most species to about one half its depth, notch sometimes continued as a groove which does not, however, extend to the clypeus. Prothorax usually bearing one or two blunt, fleshy protuberances just above the legs, sometimes reduced to mere swellings; other segments of body sometimes bearing similar swellings. Protuberances always present when the body setae are short and sparse, otherwise the setae are extremely irregular in length, ranging from very short to as long as the body is wide; setae never in pencils or verricules or on verrucae or scoli. Sometimes a gibbosity or blunt horn is found on segment 8 on the dorsomeson. Prolegs present on segments 3, 4, 5, 6, and 10 as usual; crochets biordinal, arranged in a mesoseries.

The genera may be distinguished as follows:

a. Body not bearing prominent lateroventral protuberances.
  b. Body depressed; head depressed, partially retractile. *Heteropacha*
  bb. Body cylindrical; dorsal setae as long as lateral setae.
    c. Head black, with epicranial suture inconspicuous; labral notch always deep. *Malacosoma*
    cc. Head with epicranial suture forming a conspicuous yellow inverted Y on the black background, or with pale lateral areas; labrum sometimes only shallowly emarginate at apex. *Gloveria*
aa. Body bearing conspicuous lateroventral protuberances, longest on prothorax, where they are proleg-like; longest setae situated on these protuberances, dorsal setae very short or absent.
  b. Body segments each with a pair of verruca-like swellings on the dorsum, those of segment 8 subequal in size to those of other segments. *Tolype*
  bb. Body segments without paired dorsal verruca-like swellings, but a short fleshy dorsal horn on segment 8. *Epicnaptera*

Heteropacha rileyana is small and onisciform in shape. It is more closely related to Tolype than to Malacosoma, but the fleshy processes are reduced.

Of Malacosoma, eight species are found in the United States. Most of them are large and cylindrical caterpillars with long setae. There is considerable variation in color. A table of the species has been written by Dyar and will be found in the Canadian Entomologist, 25, 1893, p. 43.

Gloveria arizonensis and *G. howardi,* the only species of this genus examined, overlap Malacosoma in most characters. In *arizonensis* the labrum has a very shallow emargination, while in the other species it is notched to about one-half its depth.

Tolype velleda has the body very much depressed and this appearance is increased by the long setae between the spiracles and prolegs. The venter is almost naked. The setae are grayish brown and the body is inconspicuously marked except for a dorsal black transverse vitta on the metathorax. The dorsal metathoracic verrucae are more prominent than those of any other segment. *Tolype laricis* is similar, except that the verrucae of the metathorax are not increased in size.

Epicnaptera americana is a large species with the setae reduced in size in the later stages. The prothoracic protuberances on each side are very large.

FAMILY EUPTEROTIDAE

This European family includes the American genus Apatelodes, usually but incorrectly listed with Notodontidae. Numerous genera of the family are found in Europe and Asia.

Head about as high as body, not retractile, about as wide as high; labral notch deep, either reaching two-thirds distance to clypeus or continued as a groove which reaches clypeus; front extending about one-third the distance to the vertical triangle; head densely covered with secondary setae, thrown back so that the mouth parts are directed almost cephalad. Body cylindrical, covered with numerous secondary setae, some short, others much longer, no fleshy protuberances or verrucae present; mediodorsal setae usually grouped into a distinct tuft on each segment, sometimes forming long pencils; setae longer in thoracic than in abdominal region and on ventral part of abdomen than on dorsal. Prolegs present on segments 3, 4, 5, 6, and 10 as usual, those of the anal segment similar to the others; crochets biordinal.

Apatelodes torrefacta has the body densely setiferous, the setae long and soft. Conspicuous pencils are borne on the dorsomeson of the last two thoracic and the eighth abdominal segments. The labrum is emarginate to about two-thirds its depth. *A. angelica* is more quietly colored, being a grayish brown. The setae of the dorsomeson are comparatively short, but grouped in a small tuft on each body segment; no pencils are present. The labrum is emarginate about half its depth and the notch is continued to the clypeus in the form of a shallow groove.

FAMILY LIPARIDAE

The caterpillars of the tussock moth family may be divided into two groups, those of the first resembling arctians, those of the second having an individuality all their own. Both divisions bear dorsal eversible glands on abdominal segments 6 and 7.

The genera of the first group have typical verrucae, the arrangement as in Arctiidae and Acronycta, except that there are three verrucae above the Kappa group on the mesothorax and metathorax. The usual variation in regard to kappa on the abdomen is to be observed, tho the fusion with rho in *Porthetria dispar* is unique. The separation or contiguity of alpha and beta is merely incidental to the amount of development of these verrucae and the area they occupy.

Group two is a contrast to the commonplace larvae of the first division, being bizarre in color and armature. The long pencils are composed of peculiar setae with spurs much longer near the tip than at the base. This gives a clavate appearance, altho the seta is not itself swollen. The locations of these ''clavate-plumed setae'' are good taxonomic characters.

Genera of Liparidae:

a. Body bearing tufted setae but no long pencils or dense verricules.
  b. Abdominal segments bearing a single large verruca, eta, below spiracle, with a very small one, mu, behind it; verruca rho fused with kappa dorso-caudad of the spiracle; verruca alpha on abdomen distinct, tho small. *Porthetria*
  bb. Abdominal segments bearing two large verrucae below spiracle, mu directly below eta; kappa, when present, distinct, behind spiracle; verruca alpha fused with beta.
    cc. Verruca kappa present and distinct, tho small; body bearing some very feathery setae. *Gynaephora*
    cc. Verruca kappa absent or indistinct; setae echinulate but not feathery. *Euproctis*
aa. Body bearing a pair of long pencils of setae on prothorax and a mesal pencil on segment 8.
  b. First four abdominal segments bearing dense dorsal verricules very different from verrucae of other segments.
    c. Clavate-plumed setae present on all or nearly all segments. (In part) *Olene*
    cc. Clavate-plumed setae present only in the tufts of the prothorax and eighth abdominal segment and sometimes on the second abdominal segment. *Hemerocampa*
Notolophus
  bb. First four abdominal segments bearing verrucae similar to those of other segments. (In part) *Olene*

Porthetria includes a single species, the Gipsy moth, *P. dispar*.

Euproctis chrysorrhea is the Browntail moth and is the only species of this European genus as yet introduced into America.

The characters given for Gynaephora in the synopsis refer to *G. rossii,* the larva of which differs greatly from *G. groenlandica.* The latter species occurs only in the Arctics.

Olene achatina differs from other members of the second group in the absence of verricules on the first four abdominal segments. The setae densely cover all parts of the body. Clavate-plumed setae are present only on the prothorax. *O. leucophaea, O. pini* Dyar, and *O. plagiata* are more similar to the common Tussock moth.

Hemerocampa and Notolophus overlap and the larvae can not be distinguished. *N. antiqua* differs from the others in the presence of clavate-plumed setae on abdominal segment 2. The others may be separated by the table given by Dyar in Psyche, 7, 1893, p. 421.

FAMILY THYATIRIDAE

Head vertical, wider than high; front small; adfrontals distinct; no secondary setae; labrum usually notched to about two-thirds its depth, sides of notch parallel. Body cylindrical, not bearing secondary setae; primary and subprimary setae arranged as described for Epiplemidae except that the Pi group on the prolegs consists of three setae only and of at least two setae on segments 1, 2, 7, and 8. Ventral prolegs bearing biordinal crochets in a curved mesoseries; anal prolegs reduced to one-half or two-thirds size of ventral.

Habrosyne rectangulata has the head shining and the Pi group on the mesothorax and metathorax bisetose. In *H. scripta* the head is more or less dull and minutely rugose, the dorsal half of the abdomen bears diagonal stripes, and the Pi group on the last two thoracic segments is unisetose.

Pseudothyatira expultrix and *P. cymatophoroides* each show a dull and rugose head and unmarked body. The Pi group is bisetose on each thoracic segment.

FAMILY NOTODONTIDAE

Larvae of this family are usually identified at a glance by their peculiar decoration and shapes. A student of the larval stage can not accede to Hampson's view that the arctians, noctuids, and syntomids are specialized modifications of the notodontian type, or that Notodontidae are a generalized family. All the species have secondary setae on the sides of the prolegs and specialized anal prolegs, thus departing widely from the generalized condition retained by Noctuidae.

Many species of the subfamily Notodontinae will trace to Noctuidae in any tables hitherto published. The setiferous prolegs will serve to distinguish in most of these cases. Other characters are given in the table for the separation of the families. The subfamilies may be recognized by the following key:

a. Body bearing numerous secondary setae, obscuring primary ones; anal prolegs not increased in size.
  b. Head bearing numerous short, fine, secondary setae; abdominal segments 1 and 8 often bearing conspicuous dorsal cornicula. MELALOPHINAE
  bb. Head without secondary setae; dorsal cornicula never present. PYGAERINAE
aa. Body bearing only primary setae above level of prolegs; anal prolegs usually elongated.
  b. Dorsum of thorax consisting of a broad flattened triangle with conspicuous lateral prothoracic and mesal metathoracic angles; anal prolegs long; head small, partially retractile. CERURINAE

bb. Dorsum of thorax not flattened nor triangular; anal prolegs not greatly elongated; head usually as large as prothorax.

NOTODONTINAE

Melalophinae. This subfamily includes the one genus Melalopha (Ichthyura). The six species may be distinguished by the characters given by Packard, (1895).

Pygaerinae. The larvae of Datana are well known in all parts of the United States. As the colors change at each molt the species are hard to separate. Packard gives a key to them which may be used with more or less success, and his figures are invaluable. He was acquainted with the larvae of all described species except *robusta, modesta,* and *chiriquensis. D. robusta* is very similar to *D. contracta* but the stripes are dark brown instead of creamy white and the prothoracic shield is black instead of yellow in the last instar.

Cerurinae. Two genera, Harpyia and Cerura, whose larvae are very similar, compose this group. The long stemapoda, or modified anal prolegs, distinguish them at a glance from other Notodontidae. In *Cerura scitiscripta* the metathorax has a single median prominence, and in *C. occidentalis* there is a bifurcate one. The metathorax of the species of Harpyia is without prominences. All have a dorsal reddish somewhat broken vitta running the entire length of the body and reaching in some places as far ventrad as the spiracle. In *H. cinerea* this vitta is wanting on the metathorax but in the other two species it is continuous from thorax to abdomen. Its lateral margins are convex on the mesothorax of *H. scolopendrina* and concave in *H. borealis.*

Notodontinae. At first glance the genera which are grouped together under this name seem rather heterogeneous. The wing venation of the adults is as various as the form of the larvae. Nevertheless a logical separation of Gluphisia and the Heterocampinae seems almost impossible. The former is very closely related to some of the Notodontinae as Packard limited the group. The species of Heterocampa form a series of transition stages from typical notodontians to the peculiarly specialized larvae of Schizura and Hyparpax. This is in striking contrast to the distinct separation of the Pygaerinae and the Ichthyurinae from other members of the family. The long stemapoda in early stages of Fentonia (Macrurocampa) seem to indicate that even Cerura and Hayrpia should be included here. Other structures, however, make the line of separation distinct. The various genera may be distinguished by means of the following synopsis. The comparative clause in the first division is due to the peculiar dorsal series of gibbosities of Nerice, a genus which clearly belongs in the second group.

Genera of Notodontinæ:

a. First abdominal segment bearing a higher dorsal gibbosity than second, gibbosity usually either bifurcate or bearing a pair of cornicula.
  b. Dorsal corniculum of segment 8 single, that of segment 1 obscurely bifurcate. *Ianassa*
  bb. Dorsal corniculum of segments 1 and 8 distinctly bifurcate.
    c. Segments 4 and 5 not gibbous above; color between humps on segments 1 and 8 mainly in a single elliptical patch; labrum notched to two-thirds its depth. *Hyparpax*
    cc. Segments 4 and 5 usually gibbous above; color between segments 1 and 8 never in a distinct elliptical patch; labrum not notched to two-thirds its depth. *Schizura*
aa. First abdominal segment not bearing a higher dorsal gibbosity than second; gibbosity, when present, neither bifurcate nor bearing a pair of cornicula.
  b. Segment 8 bearing a distinct dorsal hump or horn or pair of cornicula.
    c. Dorsal processes of segment 8 slender, horn-like.
      d. Horn single, similar to the caudal horn of a sphingid. *Pheosia*
      dd. Horns paired, slender and sharply pointed. *Ptilodon*
    cc. Dorsal hump of segment 8 broad, not horn-like.
      d. Segment 2 conspicuously gibbous above.
        e. Abdomen bearing high dorsal gibbosities on eight segments. *Nerice*
        ee. Abdomen bearing dorsal humps on not more than five segments. (In part) *Hyperaeschra*
      dd. Segment 2 not gibbous above.
        e. Segment 8 swollen and discolored over entire dorsal half; coloration mainly a series of longitudinal stripes. *Symmerista*
        ee. Segment 8 not swollen over entire dorsal half.
          f. Anal prolegs short and rounded; coloration in indefinite transverse stripes. *Odontosia*
          ff. Anal prolegs usually elongate.
            g. Head bearing a pair of dark dorsal spots. *Ellida*
            gg. Head unicolorous.
              h. Coloration principally a series of conspicuous longitudinal stripes on dorsal half of each segment and rounded spots at base of each leg. *Dasylophia*
              hh. Coloration principally a series of conspicuous trans-

verse stripes on dorsal half and longitudinal stripes on ventral half of body. *Didugua*

bb. Segment 8 not bearing a distinct dorsal hump, horn, or gibbosity.
  c. Prothorax bearing a pair of dorsal cornicula.
    d. Anal prolegs stemapodiform, about as long as body is wide, longer in early stages. *Fentonia*
    dd. Anal prolegs shorter than body is wide.
      e. Head divided by a pair of subvertical lines into three areas, the lateral minutely rugose, the mesal hard and shining. (In part) *Heterocampa*
      ee. Head not divided into three areas. *Litodonta*
  cc. Prothorax not bearing a pair of dorsal cornicula.
    d. Body bearing a distinct lateral line through spiracles or a conspicuous mediodorsal line or both; supraspiracular lines never present.
      e. Prothoracic spiracle conspicuous, about twice the height of the abdominal spiracles; second ocellus closer to first than to third.
        f. Kappa on segments 5, 6, and 8 separated from the spiracle by a distance equal to about one-half the width of the spiracle. (In part) *Hyperaeschra*
        ff. Kappa on segments 5, 6, and 8 separated from the spiracle at least as far as the spiracle is wide. *Lophodonta*
      ee. Prothoracic spiracles about the same size as abdominal spiracles or not more than one and a half times as high.
        f. Lateral lines present; second ocellus closer to first than to third; dorsal line double. *Gluphisia*
        ff. Lateral lines not present; second ocellus closer to third than to first; dorsal line single. *Misogada*
    dd. Body not bearing lateral lines through spiracles; mediodorsal line when present paralleled by a pair of supraspiracular lines on at least a part of the abdomen.
      e. Second and third ocelli closer together than first and second; anal plate usually inconspicuous, all spiracles subequal in size. (In part) *Heterocampa*
      ee. Second and third ocelli as far apart as first and second; anal plate large, semicircular, nearly as wide as segment 9; spiracles of prothorax much larger than those of abdomen. *Nadata*

A discussion of the genera of this, the largest subfamily, would be out of place in a paper of this kind in view of the excellent Monograph by Packard, but as several species have been described since the publication of that work, the following notes are offered:

Ianassa lignicolor, in all except the last stage, is very similar to *Schizura unicornis.* The striped head, with three mesal white marks in a vertical row, will distinguish it, the head of *S. unicornis* being unicolorous red.

Ptilodon americana is called *Odontosia camelina* by Packard. The larva is very distinct from *Odontosia elegans.*

Hyperaeschra shauld apparently be divided into two genera, for the larvae of *H. georgica* and *H. stragula* are very different.

Didugua Druce was erected for the species *argentilinea* Druce, found in Texas. The coloration is distinctive.

The following species of Notodontidae were examined:

Melalopha—all listed species
Datana ministra
  D. californica
  D. angusii
  D. drexelii
  D. major
  D. palmii
  D. floridana
  D. perspicua
  D. robusta
  D. integerrima
  D. contracta
Cerura scitiscripta
  C. occidentalis
Harpyia cinerea
  H. borealis
  H. scolopendrina
Ianassa lignicolor
Hyparpax aurora
  H. perophoroides
Schizura ipomoeae
  S. concinna
  S. semirufescens
  S. unicornis
  S. apicalis
  S. badia
  S. leptinoides
  S. errucata Dyar
Pheosia dimidiata
Ptilodon americana
Nerice bidentata
Hyperaeschra stragula
  H. georgica
Symmerista albifrons
Odontosia elegans
Ellida caniplaga
Dasylophia anguina
Didugua argentilinea Druce
Fentonia marthesia
Heterocampa obliqua
  H. picta
  H. umbrata
  H. manteo
  H. biundata
  H. guttivitta
  H. bilineata
Litodonta hydromeli
Lophodonta ferruginea
  L. angulosa
Gluphisia septentrionalis
Misogada unicolor
Nadata gibbosa

FAMILY DIOPTIDAE

Phryganidia californica, the only species of this family found in North America, is described and figured by Kellogg and Jackson in

Proc. Cal. Acad. Sci. (2) 5, 1895, p. 563. The larva is noctuiform and cylindrical with all the usual prolegs present altho the anal ones are slightly reduced in size. The primary setae are reduced, but easily located with a lens; secondary setae are present only on the prolegs. Labrum acutely tho not very deeply notched, as in most Notodontidae. The cuticular projections of the body are conspicuous under a magnification of about two hundred but might be overlooked with a low power objective. The color is green, with longitudinal black stripes. This insect is not found east of California.

Family Pericopidae

Head rarely or never bearing secondary setae; thoracic segments always with sigma large and distinct, close to the coxae; verrucae alpha and beta of abdomen never contiguous; verruca kappa of abdomen never reduced, always much lower on segment 7 than on segments 6 and 8; mesothorax bearing either one or two verrucae above that of the Kappa group. Otherwise closely similar to Syntomidae (Figs. 67, 68).

The larvae of the American genera and species of this family are described by Dyar (1914).

Family Nycteolidae

This family, as such, has been abandoned by Hampson and other recent lepidopterists. There is certainly no larval justification for its separation from Noctuidae, altho the position of seta vii on the head seems to be closer to the second and farther from the third ocellus than in other noctuid genera. Calling the group ''subfamily Sarrothripinae'', as Hampson does, seems best to suit the facts of both larval and adult structure.

Family Noctuidae

The Owlet moths include about one-half of the nearly seven thousand described species of Lepidoptera in North America. A uniform group of this size naturally presents great problems to the systematist and takes an amount of time disproportionate even to the size of the family. By far the majority of the unidentified and misidentified moths in the museums of the world probably belong to Noctuidae. The monumental work of Hampson, which is still in course of publication, is doing much to clear up questions of classification; but no amount of discussion can make a problem of this size easy of solution.

In the larvae the difficulties facing the taxonomist are intensified. With the exception of half a dozen genera, noctuid larvae are so uniform in structure that one can often compare, part by part, every segment and appendage of larvæ of two species without finding a difference either of kind or of degree. On the other hand the half-dozen exceptions include species which resemble arctians, lasiocampids, notodontids, eupterotids, etc., and which have been distributed by some authors into a variety of families. Naturally it is the latter forms which are most difficult to handle in a synopsis of the entire order but which are easy to separate from each other.

It is not a part of the plan of this paper to enter the subject of the classification of Noctuidae. The range must, however, be considered. Many of the larvae are of such structure that they will not trace to the correct family in any tables hitherto published. It is clear that different characters must be used in identification according as the setae are primary or secondary or developed into tufts, the crochets biordinal or uniordinal, and the body cylindrical or with prominent humps. We must then divide the family into four groups, of which the first will include nearly all the genera, most of the larvae being of the ''cutworm'' type, and the others will be confined to the genera Demas, Panthea, Acronycta, Harrisimemna, Agriopodes, Polygrammate, and a few others of minor importance. Larvae of Acronycta will be found in all groups except the first, but species of the other genera mentioned are few in number and individuals rare. These ''groups'' are purely for convenience and do not constitute a ''natural'' arrangement.

Group 1. Larvae with primary setae only; prothorax with beta above level of alpha, epsilon associated with rho between delta and spiracle, Kappa and Pi groups each bisetose; mesothorax with alpha associated with beta, epsilon with rho, and kappa with eta, theta separate, Pi group unisetose; metathorax similar. Abdominal segments 1 to 6 and 8 with alpha above level of beta, rho above level of spiracle; epsilon, when present, smaller, and located cephalodorsad of spiracle, kappa and eta widely separated, mu present, Pi group consisting of three setae on most segments; sigma present; no other setae present except sometimes a few members of the Tau group and sometimes gamma; segment 7 similar, except that kappa is always much lower and closer to eta; segment 9 with alpha, beta, and rho forming a triangle, kappa, eta, mu, pi, and sigma present. Prolegs present on segments 5, 6, and 10, at least, and usually on segments 3 and 4; crochets arranged in a mesoseries, uniordinal except in some Plusiinae and others, in which the crochets are biordinal. This group contains the vast majority of genera but none of the species of Acronycta. (Figs. 17-24, 29-32.)

Group 2. Larvae with well developed verrucae (Figs. 65, 66). Arrangement of tufts similar to that in Arctiidae except that kappa is lower on segment 7 than on segments 6 and 8 (scarcely lower in Charadra); in one-fourth of the species kappa is reduced to one or a few setae and is easily overlooked. The crochets of the species of Acronycta are always uniordinal and the full five pairs of prolegs on segments 3 to 6 and 10 are always present. The notch of the labrum is somewhat varied, but, as a rule, is deep, with parallel sides and a rounded bottom. Twenty-two of the forty-two species of Acronycta examined appear to belong in this group, as well as *Charadra deridens, Panthea furcilla, Demas propinquilinea,* the species of Eulonche, Simyra, Polygrammate, Agriopodes, and possibly a few other Acronyctinae.

Group 3. Verrucae obscured by the development of secondary setae. This large number of secondary setae covers all the characters ordinarily used in the identification of noctuids and necessitates a search to find other distinguishing structures. It happens, however, that no other multisetiferous larvae have uniordinal crochets and short prolegs except Datana and Melalopha of the Notodontidae, and these are so distinctive in appearance that there is little danger of confusing Acronycta with them. The parallel-sided notch of the labrum is also distinctive*. Fifteen of the species of Acronycta examined are of this type.

Group 4. Verrucae reduced to single setae or small or indefinite groups of setae in the last instar altho preceded by well developed tufts in earlier stages. In accordance with a well recognized natural law, degeneration of a structure does not result in a condition exactly similar to that from which the structure arose. Thus the reduction of verrucae to single setae almost never causes a complete return to the generalized chaetotaxy. In Lithosiidae this is shown by the double nature of Rho on the abdomen and of Pi on the mesothorax and metathorax, and in Arctiidae by the multisetiferous leg-plate of Doa or the bisetose Pi group on the metathorax of Utetheisa. Both these latter conditions are found in that anomalous, notodontid-like, noctuid genus Harrisimemna. In the Acronyctas, however, the leg-plate seems to have been reduced to three setae and the Pi group on the metathorax to one seta at the same time that alpha, beta, rho, etc., degenerated from verrucae to single setae. It is a strange fact that mu has not followed the same course but retains its multisetiferous condition as a well developed verruca. This is true of all the "single-haired" Acronycta larvae examined, viz., *A. exilis, A. haesitata, A. afflicta,* and *A. funeralis.*

In any synopsis of the larvae for purposes of identification, the four groups must be handled separately in spite of the fact that they have all been derived from the same type. They are listed above in

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*The labrum of *Acronycta leporina,* which belongs here, is figured by Forbes (1910) as having a shallow notch. This does not agree with the individuals of this species which I have seen nor with any other Noctuidae having numerous secondary setae obscuring the verrucae, so far as I know them.

the order in which they seem to have arisen; first the primary setae, then the development of verrucae, which later became modified either by the addition of numerous secondary setae, or by reduction to almost the primary chaetotaxy again. In the absence of justification in adult structure, it does not seem best to separate the last three groups from the first as a distinct family, as has been done by some previous workers.

Family Agaristidae

This family should meet the same fate as Nycteolidae and be included among the noctuids. The adult structure on which it is based, the clubbed antennae, is so variable that it is hard to limit the group exactly. At the same time the larvae seem to be distinguishable from the Noctuidae only in color, nearly all the species being transversely striped. The one species found east of the Rocky Mountains and north of Florida, *Alypia octomaculata,* may be recognized by the humped eighth abdominal segment, the conspicuous chalazae and the transverse stripes. That is the extreme, however, for the western species form a nearly complete series connecting Alypia with typical Noctuidae. The following species were examined: *Alypia octomaculata, A. langtonii, A. ridingsii, Copidryas gloveri, C. cosyra* Druce, *Androloma mac-cullochii.*

Family Arctiidae

Head smooth, bearing sparse secondary setae or none; front about as wide as high, extending half way to vertical triangle; labrum with a rather wide, shallow emargination, sometimes acute at bottom; ocelli various, the fifth and sixth distant from the others. Body bearing verrucae except in a few reduced genera, *Doa* and *Utetheisa,* in which only primary setae and a few others remain; usual positions of verrucae shown in Figs. 25 to 28, 33, and 34. Verrucae of Beta and Rho groups of mesothorax and metathorax never fused; Kappa of abdominal segments 1 to 8 always distinctly present near spiracle, sometimes, but rarely, slightly lower on segment 7 than on segments 6 and 8; prolegs with uniordinal crochets in a mesoseries, heteroideous in all but a few species. (Fig. 107.)

The author is not satisfied with the following table of the genera but presents it in the hope that it may be of some service. Arctian larvae seem not to possess constant characters of generic value.

a. Verrucae reduced to chalazae bearing single setae.
  b. Head and thorax normal in size; crochets heteroideous. *Utetheisa*
  bb. Head very small, thorax swollen; crochets homoideous. *Doa*
aa. Verrucae not reduced, multisetiferous.

b. Subdorsal setae of thorax, at least of metathorax, twice as long as those of middle abdominal segments, usually forming pencils.
  c. Verrucae rho of segment 8 of abdomen each bearing a long pencil of setae; other setae of segments 8 and 9 short. *Halisidota*
  cc. Verrucae rho of segment 8 not bearing longer setae than verrucae alpha and beta.
    d. Body and setae unicolorous, never black. *Ammalo*
    dd. Body bearing black, white, and orange colored tufts of setae on the abdomen. *Euchaetias*
bb. Subdorsal setae of thorax subequal in length to those of abdominal segments.
  c. Labrum notched to at least half its depth.
    d. Each verruca bearing setae of two distinct lengths, the shorter sheared off even, the others fewer, twice as long, irregular in length. *Hemihyalea*
    dd. Each verruca bearing setae of only one or of irregular lengths.
      e. Cuticula and setae pale; setae sheared off even; size small. *Eupseudosoma*
      ee. Cuticula and setae very dark, with pale transverse stripes; size very large. *Ecpantheria*
  cc. Labrum notched to less than half its depth.
    d. Thoracic and caudal abdominal segments bearing setae of a different color from those of proleg-bearing segments.
      e. Setae of four to six middle abdominal segments brown, those of thorax and caudal abdominal segments black. *Isia*
      ee. Setae of most of abdomen black, those of thorax and end of abdomen brown. *Platyprepia*
    dd. Thoracic and caudal abdominal segments not bearing setae of a different color from those of proleg-bearing segments.
      e. Each abdominal verruca bearing setae of two contrasting colors, white and black; cuticula unicolorous, without a mediodorsal stripe.
        f. White setae about twice as long as black. *Arctia*
        ff. White setae about same length as others. *Ectypia*
      ee. Each abdominal verruca bearing setae of one color only, except when a bright mediodorsal stripe is present.
        f. Verrucae alpha of abdomen about one-third the size of verrucae beta; all verrucae small; setae of segments 8 and 9 not longer than those of other parts of body.
          g. Verrucae kappa of middle abdominal segments partially or entirely above level of lower margin of spiracle. *Apantesis*

gg. Verrucae kappa of middle abdominal segments well below level of spiracle.
  h. All abdominal verrucae below level of beta pale, verrucae beta black; body marked with longitudinal stripes. *Hyphantria*
  hh. All abdominal verrucae black; setae of verrucae rho sometimes forming pencils; no stripes. *Eubaphe*

ff. Verrucae alpha of abdomen about the same size as verrucae beta; when distinctly smaller, segments 8 and 9 bear setae about three times as long as those of other segments.
  g. Segments 1, 2, and 7 bearing two verrucae at the same level in line with verruca mu of segments 3 to 6; setae short; body longitudinally striped. *Haploa*
  gg. Segments 1, 2, and 7 bearing only one verruca in line with verruca mu of segments 3 to 6.
    h. Subdorsal setae of segments 8 and 9 three times as long as those of any other segments; over twice as long as body is wide. *Leptarctia*
    hh. Subdorsal setae of segments 8 and 9 usually subequal in length to those of other segments, never twice as long as body is wide.
      i. Labrum very shallowly concave at tip; verrucae alpha large, bearing black setae; verrucae beta and rho smaller, with white setae. *Euschausia*
      ii. Labrum rather acutely tho not deeply notched at tip; verrucae alpha and beta not of contrasting colors.
        j. Verrucae beta of first few abdominal segments nearly directly caudad of alpha; verrucae low, flat.
          k. Setae very irregular in length, some as long as body is wide. *Hyphoraia*
          kk. Setae sheared off even, never as long as body is wide.
            l. Setae of thorax black, those of abdomen brown. *Phragmatobia*
            ll. Setae of thorax and abdomen brown. *Lerina*
        jj. Verrucae beta of first few abdominal segments more nearly laterad than caudad of alpha; verrucae swollen.

k. Dorsum bearing conspicuous transverse yellow and black stripes; verrucae light brown. *Seirarctia*

kk. Dorsum not bearing transverse stripes, except sometimes obscurely.

l. Verrucae eta of abdomen twice as broad as verrucae mu, pear-shaped; head black at least in part; body bearing a pale lateral stripe; setae moderately stiff. *Estigmene*

ll. Verrucae eta of abdomen elongate, with parallel sides, similar to verrucae mu, head usually entirely pale; no lateral stripe of a lighter color than dorsum.

m. Setae light brown or gray, unicolorous, rather soft like fur. *Diacrisia*

mm. Setae either very dark brown, or black, or variegated in color, always stiff like spines. *Arachnis*

The following species were examined:

Utetheisa bella
Doa ampla
Halisidota maculata
  H. tessellaris
  H. harrisii
  H. cinctipes
  H. caryae
Ammalo tenera
  A. eglenensis
Euchaetias egle
Hemihyalea edwardsii
Eupseudosoma involutum
Ecpantheria muzina
Isia isabella
Platyprepia virginalis
Arctia caia var. *americana*
Ectypia bivittata
Apantesis virgo
  A. virgo var. *citrinaria*
  A. virguncula
  A. michabo
  A. anna var. *persephone*
  A. arge
  A. proxima var. *autholea*
  A. nevadensis var. *superba*
  A. phyllira
  A. figurata
Apantesis (cont'd)
  A. nais
  A. nais var. *radians*
  A. nais var. *phalerata*
Hyphantria cunea
  H. textor
Eubaphe opella
Haploa clymene
  H. colona
  H. lecontei var. *confinis*
  H. confusa
  H. contiguus
Leptarctia californica
Euschausia ingens
  E. argentata
Hyphoraia parthenos
Phragmatobia fuliginosa
Lerina incarnata
Seirarctia echo

Estigmene acraea
E. congrua
Diacrisia rubra
D. virginica
D. latipennis
Arachnis zuni
A. picta
A. confusa Druce

FAMILY LITHOSIIDAE

The Lithosiidae are arctian in most particulars and some of the larvae are said to be indistinguishable from that family. When verrucae are present, those of the last two thoracic segments are out of line instead of being in definite transverse rows, and usually only one verruca is present between the spiracle and the proleg in addition to the single seta kappa. Of the American forms the writer has seen only species with the armature reduced to single setae and is unable to describe the positions of the verrucae in other genera.

The arrangement of the setae is similar to that in Noctuidae except in two or three particulars. The Pi group on the mesothorax and metathorax is bisetose and Rho on the first six or eight abdominal segments is bisetose. An additional seta is also present near mu on the abdominal segments but the Pi group consists of only three setae. The crochets are homoideous. The labrum is shallowly concave at tip.

Hypoprepia miniata. The three setae composing the Kappa group on the mesothorax placed on one triple chalaza, equidistant from each other and arranged in a horizontal line.

Illice nexa. The three setae composing the Kappa group on the mesothorax not borne on the same chalaza, theta much farther caudad than kappa and eta, which are close together, kappa farther ventrad than the others.

FAMILY SYNTOMIDAE

The Syntomidae are differentiated by the single verruca above that of the kappa group on the last two thoracic segments. The only other similar condition is in one genus of Pericopidae but the position of verruca kappa on segment 7 serves to distinguish the latter from this family (Figs. 67, 68).

Head similar to that of Arctiidae; front almost an equilateral triangle; labrum moderately acute at tip; secondary setae usually present. Body bearing verrucae, usually well developed. Prothorax with verrucae rho rudimentary, but those of kappa and Pi groups large; mesothorax and metathorax with all setae above Kappa group forming a single verruca; Pi normal; sigma small or wanting. Abdominal segments 1 to 8 (Figs. 67, 68) with alpha, beta, rho, kappa, eta, and mu distinct and separate verrucae; kappa often small, in about the same position on segment 7 as on other abdominal segments; Pi group also forming a verruca on segments 1, 2, 7, 8, and 9; verrucae alpha often contiguous on abdomen; secondary setae rare or absent. Thoracic legs well developed; prolegs normal on segments 3, 4, 5, 6, reduced or wanting on 10; crochets uniordinal, either homoideous or heteroideous, arranged in a mesoseries.

Genera of Syntomidae:

a. Verrucae reduced in size, each bearing a few long setae; head bearing long setae; prothoracic legs much reduced. *Lycomorpha*
aa. Verrucae well developed, at least alpha, beta, and rho consisting of very numerous setae.
  b. Verrucae kappa and eta of abdomen both well developed and bearing numerous setae.
    c. Verrucae kappa of segments 1 and 7 of the abdomen bearing an enlarged group of clavate-plumed setae, tipped with black. *Cosmosoma*
    cc. Verrucae kappa of segments 1 and 7 normal.
      d. Clypeus emarginate at tip, with a median semicircular concavity; front white, adfrontals black; verrucae alpha of first abdominal segment bearing a dark brown pencil. *Lymire*
      dd. Clypeus not emarginate at tip; front concolorous with adfrontals; verrucae alpha of segment 1 normal.
        e. Secondary setae absent on front; margins of front strongly convex. *Eucereon*
        ee. Secondary setae of front rather numerous; margins of front nearly straight. *Ctenucha*
  bb. Verrucae kappa of abdomen abortive, either less than half the size of verrucae eta or both rudimentary.
    c. Verrucae beta of segment 8 bearing a pencil of setae at least twice as long as those of verrucae beta on preceding segments. *Syntomeida*
    cc. Verrucae beta on segments 1 to 9 all similar.
      d. Verrucae alpha and beta of abdomen much better developed than other verrucae, bearing a thick, short verricule on each segment. *Pseudomya*
      dd. Verrucae alpha and beta of abdomen similar to verrucae rho and kappa and those of the thorax. *Scepsis*

The following species were examined:

Lycomorpha pholus
Cosmosoma myrodora Dyar (1907)
Lymire edwardsii
Eucereon confine
Ctenucha virginica
Syntomeida epilais
  S. ipomeae
Pseudomya minima
Scepsis fulvicollis
Syntomis phegea of Europe

SUPERFAMILY SATURNIOIDEA

Workers differ as to the number of families into which this group should be divided, some defining the Saturniidae and Ceratocampidae, others separating Hemileuca and a few related genera from the former and calling them Hemileucidae. While the writer recognizes these three families, the structure of the larvae compels him to differ from previous workers and to include Automeris and Coloradia in the Hemileucidae. The necessity for this change will be shown in a succeeding paragraph. It is interesting to note that Miss Edna Mosher* found that the pupal characters also relate Automeris more closely to the Hemileucidae than to Samia and Saturnia. Whether specialists will later find that the imagines justify this arrangement remains to be seen.

The difference is emphasized by the basis of separation of the Saturniidae from the Ceratocampidae. Forbes (1905), following Dyar, uses for this purpose the scoli beta on the ninth abdominal segment, which in Ceratocampidae are fused on the dorsomeson. He seems to have overlooked the fact that such a fusion also occurs in Automeris (Fig. 109) and other genera, with the result that these forms trace to Ceratocampidae or Hemileucidae rather than to Saturniidae.

Five types of arrangement of the scoli of segments 8 and 9 are found in the superfamily and four of them are shown in the figures of Plate X. In all five, scoli Rho and Kappa are normal on segment 8, and two similar but more dorsally placed scoli of doubtful homology are found on 9. Dorsad of these four are found the following modifications: (a) a single mediodorsal scolus on 8, none on 9; (b) a subdorsal scolus on each side on 8, none on 9; (c) a mediodorsal scolus on 8, and also one on 9; (d) a mediodorsal scolus and pair of adjacent scoli on 8 and a mesal one only on 9; (e) a mediodorsal scolus on 9, none on 8. The Saturniidae display either (a) (Fig. 108) or (b); the Hemileucidae, including Automeris, are armed as in (c) (Fig. 109); while the Ceratocampidae show either (d) (Fig. 110) or (e) (Fig. 111). It is to be noted that Hemileuca, Pseudohazis, Automeris and Coloradia are more similar to the Ceratocampidae in the armature of these two segments than to the Saturniidae.

The presence of scoli (Figs. 73, 74) distinguishes this superfamily from all others except Nymphalidae and Heliconiidae. In the Saturnioidea, however, the head is never tuberculate nor horned and is always more or less narrowed dorsad; mediodorsal scoli, when present, are confined to segments 8 and 9. The few difficult cases which remain are discussed under Nymphalidae. The position and number of the scoli differ so greatly that an extended diagnosis of the entire group on that basis is impossible. They are never absent in American species so far as examined, but in the last stage of the European *Aglia tau,* only great dorsal gibbosities remain to show that the recent form has descended from saturnian ancestors.

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*The Classification of the Pupae of the Ceratocampidae and Hemileucidae. Ann. Ent. Soc. Am. 7, 1914, 277-300.

Beta on the first eight abdominal segments of members of this superfamily is either represented by a single seta or is wanting. The eighth segment of Ceratocampidae is an exception, for here there is a pair of small scoli caudad of the large mediodorsal scolus alpha.

The crochets are always biordinal and arranged in a mesoseries. (Fig. 106). The anal prolegs are usually flattened laterocaudally and, with the anal plate, form a triangular pyramid.

Families of Saturnioidea:

a. Ninth abdominal segment not bearing a scolus on the dorsomeson; scoli never profusely branched; mediodorsal scolus of segment 8, when present, never associated with a pair of smaller scoli laterocaudad of it (Fig. 108). SATURNIIDAE

aa. Ninth abdominal segment bearing a scolus on the dorsomeson (Figs. 109, 110, 111).

  b. Scoli alpha of mesothorax scarcely longer than abdominal scoli; latter often profusely branched; anal plate smooth. HEMILEUCIDAE

  bb. Scoli alpha of mesothorax at least twice as long as scoli of abdominal segments 1 to 6; scoli never profusely branched; anal plate bearing at least one pair of small chitinous processes. CERATOCAMPIDAE

Genera of Saturniidae:

a. Eighth abdominal segment bearing a scolus on the dorsomeson.

  b. Scoli alpha of mesothorax and metathorax subequal in size to or smaller than other body scoli; scolus Pi never present on abdominal segments 1 and 2.

    c. Scoli well developed and conspicuous, cylindrical, higher than wide. *Philosamia*

    cc. Scoli reduced to small knobs not higher than wide.

      d. Labrum notched to about one-half its depth; secondary setae rare or absent on dorsum. *Rothschildia*

      dd. Labrum notched to three-fourths its depth; secondary setae common on dorsum.

        e. Abdominal segments 1 to 7 each bearing a transverse yellow intersegmental stripe; scoli Rho and Kappa not connected by a yellowish ridge; spiracle much closer to scolus Kappa than to Rho. *Tropea* ee. Abdominal segments not bearing intersegmental stripes but scoli Rho and Kappa connected by a yellowish ridge; spiracle about half way between scoli Rho and Kappa. *Telea*

bb. Scoli alpha of mesothorax and metathorax larger than those of abdominal segments 2 to 6.

c. Abdominal segments 1 and 2 bearing two scoli below spiracle; scoli alpha of first abdominal segment much larger than those of second. *Samia*

cc. Abdominal segments 1 and 2 bearing one scolus or none below spiracle, or sometimes a second one, very rudimentary; scoli alpha of first abdominal segment not much larger than those of second. *Callosamia*

aa. Eighth abdominal segment not bearing a scolus on the dorsomeson.

b. Secondary setae numerous and long, obscuring the scoli, which are reduced. *Agapema*

bb. Secondary setae rare or absent; scoli conspicuous, subequal in size on all segments. *Saturnia*

Genera of Hemileucidae:

a. Lateral spinules of supraspiracular scoli rho usually sparse, not obscuring axis of scolus; head smaller than prothorax; secondary setae often numerous; labrum shallowly notched.

b. Scoli alpha of abdomen modified into verricules strikingly different from other scoli.

c. Body covered with small white dots, each dot surrounding the base of a secondary seta; colors variegated. *Hemileuca*

cc. Body not covered with white dots, unicolorous (except in *P. hera*). *Pseudohazis*

bb. Scoli alpha of abdomen similar to those of other parts of the body. *Coloradia*

aa. Lateral spinules of supraspiracular scoli Rho long, thickly set, obscuring axis of scolus; head larger than prothorax; secondary setae of body rare; labrum notched to more than one-half its depth. *Automeris*

Genera of Ceratocampidae:

a. Secondary setae numerous, conspicuous, and distinctly longer than scoli of abdomen. *Basilona*

aa. Secondary setae above level of prolegs inconspicuous.

b. Eighth abdominal segment bearing a scolus on the dorsomeson (Fig. 110); armature of metathorax similar to that of mesothorax.

c. Prothorax bearing well developed scoli; abdominal scoli slender, echinulate. *Citheronia*

cc. Prothorax bearing rudimentary scoli; abdominal scoli broad at base, pointed, smooth.
  d. Scoli of abdominal segments 1, 3, and 5 one fourth as long as those of 2, 4, and 6; those of segment 9 abortive. *Adelocephala*
  dd. Scoli of abdominal segments 1 to 6 uniform in size; those of segment 9 conspicuous. *Syssphinx*
bb. Eighth abdominal segment without a scolus on the dorsomeson (Fig. 111). *Anisota*

Philosamia cynthia is the only American species of its genus. The caterpillars have a creamy appearance owing to a powdery bloom which somewhat obscures the blue scoli.

Rothschildia jorulla was studied but *R. orizaba* has not been seen.

Tropea luna, when the caterpillar is fully grown, is of a clear green color on both its head and body. On the caudal margin of each abdominal segment there is a transverse yellow line and another on either side of the body below the spiracles. The scoli are reddish in color and rather small in size.

Telea polyphemus is very similar to *Tropea luna* except in the characters given in the key.

Samia cecropia was the only one of the North American species of this genus examined. The enlarged dorsal scoli of the mesothorax, metathorax, and first abdominal segment distinguish this species from all other members of the family.

Callosamia. Two species of this genus occur in the eastern states and one (*C. calleta*) in the southwest, Mexico and Arizona. They may be distinguished as follows:

a. Scoli of first eight abdominal segments reduced or absent in last larval instars.
  b. Abdomen bearing a distinct longitudinal subspiracular yellow ridge. *C. angulifera*
  bb. Abdomen not bearing a subspiracular ridge. *C. promethea*
aa. Scoli of first eight abdominal segments conspicuous, those of first segment largest; body marked with black, base of scoli red. *C. calleta*

Agapema anona is a conspicuously marked yellow and black species with a black head. *A. galbina* has not been seen.

The three species of Saturnia examined *(pavonia-major, pavonia-minor,* and *spini)* are all exotic. The larva of *S. mendocino* seems not to be known at the present time.

Hemileuca. In both this genus and Pseudohazis the scoli alpha of the last two thoracic and first eight abdominal segments are modified into verricules or thick bunches of short stiff setae. Other scoli are normal. Three species *(grotei, juno,* and *tricolor)* have not been seen. *Pseudohazis hera* is included in the following synopsis of the species of Hemileuca because the writer was unable to distinguish between specimens of the larvae labeled with this name in the United States National Museum and those of *H. electra.*

a. Verricules alpha of mesothorax each surrounding a scolus which arises from its center and makes the verricule conspicuously different from those of the metathorax.
  b. Secondary setae numerous, about half as long as scoli and often as long as verricules. *H. neumoegenii*
  bb. Secondary setae when present sparse and short.
    c. Dorsal abdominal verricules yellow or light brown, always lighter in color than the scoli.
      d. Body with pale areas conspicuous, more extensive than dark areas. *H. nevadensis*
      dd. Body very dark, pale areas confined to minute dots. *H. maia* var. *lucina*
    cc. Dorsal abdominal verricules as dark in color as the scoli, usually dark brown or black, at least at tip. *H. maia*
aa. Verricules of mesothorax similar to those of metathorax, not surrounding scoli.
  b. Secondary setae numerous, subequal to dorsal verricules in length. *H. electra*
  Pseudohazis hera
  bb. Secondary setae sparse, much shorter than verricules. *H. hualapai* var. *oliviae*

Pseudohazis. Whatever the family arrangement in Saturnioidea, *Pseudohazis* and *Hemileuca* must be placed together for they are very similar. The difference given in the synopsis is not a good one (altho it seems to hold for all species except *Pseudohazis hera* of the north Pacific states) but I am unable to improve on it at present. *P. hera* may be separated from the other species by the numerous white dots at the bases of the secondary setae and is thus a typical Hemileuca. In *P. eglanterina* most of the setae are light in color but the body and verricules are a dead black. The verricules of *P. shastaensis* are light in color at base and tipped with black, the body color varying in different individuals.

Automeris. The caterpillar of the Io moth *(A. io)* is well known and its poisonous spines are rather notorious. The variety *fuscus* Luther, also found in the Eastern states, has the scoli much smaller, leaving a great part of each segment unprotected. In *io* the entire body surface seems to be covered.

Coloradia pandora was seen only in the early larval stages, when the scoli are long and sparsely branched. These may possibly become reduced in the mature larva. Between and slightly behind scoli Rho and alpha on the abdomen is a single seta, beta.

Basilona imperialis. The larva of the yellow imperial moth is well known; the long setae enable it to be identified at a glance.

Citheronia. The caterpillar of *C. regalis* is commonly known as the "Hickory Horned Devil", the horns being the subdorsal scoli of the meso- and metathorax. In this species each of these segments is armed with a pair of very long scoli on each side while in *C. sepulchralis* but one long scolus is found on each side on each of the two segments; in other words the former species has scoli Rho very well developed on the thorax, while in the latter scolus Rho is no larger than Kappa or Pi.

Adelocephala. The one species of this genus, *A. bicolor,* is very similar to Syssphinx in the larval stage, but the reduced armature on each alternate abdominal segment and the echinulate mesothoracic scoli serve to separate them.

Syssphinx. Peculiar smooth processes, similar to the thorns of a rose, take the place of scoli in *S. heiligbrodti,* the only species I have examined, and make it recognizable at a glance. Even the thoracic scoli are nearly smooth. As the genus is distinct from other Saturnians in adult characters, it is probable that these processes occur in the other two American species, *S. bisecta* and *S. quadrilineata.*

Anisota. While the species of *Anisota* are very common, their small size and plain appearance have caused them to attract less attention than their relatives. They may be easily distinguished from each other as follows:

a. Scoli alpha of abdominal segments 1 to 6 very much reduced and inconspicuous; scoli Kappa well developed; caudal projections of suranal plate scarcely longer than lateral processes. *A. rubicunda*
aa. Scoli alpha of abdominal segments 1 to 6 subequal to Kappa in size.
  b. Scoli alpha of abdominal segments 1 to 6 much shorter than thoracic legs.
    c. Caudal projections of suranal plate distinctly longer than wide, pointing directly caudad; body with conspicuous black longitudinal stripes, not dotted. *A. senatoria*
    cc. Caudal projections of suranal plate about as long as base is wide, pointing caudodorsad; body without black stripes but covered with minute dots. *A. virginiensis*

bb. Scoli alpha of abdominal segments 1 to 6 conspicuous, about as long as thoracic legs.

c. Body uniformly and closely tuberculate, stripes faint. *A. stigma*

cc. Body irregularly and rather sparsely tuberculate; stripes conspicuous. *A. consularis*

Thauma and *Hylesia.* No specimens of these genera were available for study.

SUPERFAMILY SPHINGOIDEA

The Sphingidae, the only members of this superfamily, include some of our largest caterpillars. The variation in structure, while not great, is, according to Forbes (1911) sufficient to enable the different genera to be easily identified. His synopsis of the genera and discussion of the species are of great value to anyone with larvae to determine. The family characters are as follows:

Head usually smaller than prothorax, usually partially retractile, shorter in dorsal than in ventral portion, always more or less narrowed above; head in Lapara high and conical above, much higher, tho no wider, than body; setae of head minute and numerous, present on all parts except labrum and mouth parts; front reaching less than half the distance to vertical triangle; labrum variously notched. Body cylindrical, plump; secondary setae present on prolegs but rare or absent on body; primary setae reduced or wanting; when present, kappa and eta distant, eta farther dorsad than kappa and almost as high as spiracle; segment 8 bearing a slender horn in most genera; when reduced, a scar or corniculum marks its location except in Lapara. Prolegs present and large, set close together, bearing biordinal crochets arranged in a mesoseries. Anal prolegs flattened laterad, forming, with the suranal plate, a triangular pyramid.

RHOPALOCERA

The butterflies seem to have been separated from other Lepidoptera at a very remote period. They have been specialized in all stages along entirely different lines. The larvae seem to have separated from the Microlepidoptera before the time when kappa and eta became adjacent on the abdomen.

Scudder's ''Butterflies of the Eastern United States and Canada'' is at present *the* authority on all stages of Rhopalocera. So many entomologists have no access to a copy of this beautiful but expensive work, however, that it is considered worth while to cover the group so far as possible here. Many of the characters are adapted from his descriptions and a free use has been made of his method of separating the genera.

On the basis of larval structure the butterflies may be divided into about five groups. In the Hesperioidea, including the Hesperiidae and Megathymidae, the crochets are triordinal and arranged in a complete circle, and the body bears very short numerous secondary setae but no other form of armature. The larvae of the Lycaenoidea (the Lycaenidae and Riodinidae) are somewhat onisciform in shape, the head small and retractile, the body covered with coarse secondary setae. Forbes has called attention to the peculiar form of the prolegs, which bear an interrupted mesoseries of crochets with a spatulate fleshy lobe arising near the interruption. The Papilionidae and Parnassiidae are characterized by the presence of prothoracic osmateria; in the former the body is practically without setae, but both secondary setae and verrucae are present in the latter. The Pieridae are considered by many as belonging to the Papilionoidea but the larvae are not closely related. All the remaining families, Libytheidae, Lymnadidae, Ithomiidae, Heliconiidae, Agapetidae, and Nymphalidae, may be grouped together as Nymphaloidea, altho they have few larval structures in common. They are all armed with scoli or fleshy filaments or a bifurcate suranal plate, except the Libytheidae, which are distinguished from the others by the pseudocircular arrangement of the crochets.

Family Hesperiidae

The conspicuous structure of the larvae of skippers is the large head attached to a strongly constricted ''collar''. This head is covered with numerous secondary setae, often plumose but never long, sometimes borne on chalazae. The labrum is shallowly concave at tip and usually a shallow mesal groove is present on the cephalic surface. The front extends about two-thirds of the distance to the top of the head.

The body is either cylindrical or fusiform, widest at the proleg-bearing segments, usually tapering considerably toward each end; secondary setae numerous, often very short; small flattened plates sometimes present, possibly showing position of primary setae; segments divided into indistinct annulets, incisions all shallow or obscure; prothoracic shield narrow, often indistinct. Prolegs with triordinal crochets in a complete circle.

Scudder divides the family into Hesperidi and Pamphilidi and gives a table for the separation of the genera of the former group in all stages. The family is so poorly represented at the National Museum that at present nothing can be added to his work.

FAMILY MEGATHYMIDAE

No species of this small family is found east of the Rocky Mountains and even there the boring habit of the larvae makes their discovery difficult. Three specimens of *Megathymus yuccae* have been examined and the following characters are taken from them.

Head rounded, about as high as wide, rugose, partially retractile, smaller than prothorax; front triangular, sides almost straight, reaching about half way to top of head; labrum with a small, acute, mesal notch; setae very much reduced; ocelli small, inconspicuous. Prothoracic shield narrow, sometimes indistinct; setae of body much reduced, apparently wanting on its dorsal half, numerous and short on ventral half of first two thoracic segments, rare or absent on abdomen, except on prolegs. Thoracic legs well developed, bearing numerous setae on their caudomesal surfaces; prolegs short, bearing a complete ellipse of biordinal crochets, series sometimes slightly broken at mesal and lateral ends; spiracles large, those of segment 8 placed somewhat farther dorsad than the others.

FAMILY LYCAENIDAE

Head from one-sixth to one-half as wide as body, usually deeply retractile, often overhung by the prothorax; front broad, often extending over half way to vertical triangle; labrum various. Body depressed, widest above prolegs, usually tapering strongly toward the ends; secondary setae numerous, sometimes in tufts and pencils, usually coarse and short. This form of body does not occur elsewhere in Lepidoptera except in the Zygaenoidea. Prolegs with a mesoseries of triordinal crochets well developed at the ends of the series, shorter or interrupted at the middle, and with a spatulate or clavate fleshy lobe arising near the interruption (Fig. 79).

From the very meager material at hand, the following synopsis has been prepared. It follows to some extent that of Scudder:

a. Head at least one-third the diameter of the body.
  b. Head about one-half the diameter of the body.
    c. Verrucae large and distinct, with short setae. *Eumaeus*
    cc. Verrucae inconspicuous or absent, setae long, arranged in transverse groups. *Feniseca*
  bb. Head about one-third the diameter of the body.
    c. Lateral line continuous and rather conspicuous.
      d. Prothorax longer and higher than mesothorax; abdomen marked by a pair of subdorsal lines between mediodorsal and lateral lines. *Mitoura*

dd. Prothorax much smaller than mesothorax; abdomen usually not marked by subdorsal lines. *Thecla*

cc. Lateral line discontinuous and faint or absent.

d. Labrum notched to about one-third its depth. *Chrysophanus*

dd. Labrum very shallowly concave at tip.

e. Body widest in metathoracic region, tapering rapidly cephalad and gradually caudad.

f. Fifth ocellus located below center of arc formed by first four ocelli; second ocellus out of line, making arc uneven. *Calycopys*

ff. Fifth ocellus located at center of arc formed by first four ocelli; arc regular, even. *Heodes*

ee. Body widest in region of segment 6 of abdomen, tapering gradually cephalad and rapidly caudad. *Uranotes*

aa. Head less than one-fourth the diameter of the body.

b. Body marked by longer setae on outer margin of narrow dorsal area than on other parts.

c. Anal segment broad and greatly depressed. *Everes* *Philotes*

cc. Anal segment narrow and moderately depressed. *Cyaniris*

bb. Body covered with setae of uniform length throughout.

c. Setae of body long, closely set; vertical triangle rather broad. *Nomiades*

cc. Setae of body short, rather sparse; vertical triangle very narrow. *Rusticus*

This synopsis was prepared to cover the following species. All were examined in the National Museum except those marked with an asterisk and they are carefully described by Scudder:

Eumaeus atala
Feniseca tarquinius
Mitoura damon
Thecla adenostomatis
  T. edwardsii
  T. liparops
  T. calanus
  T. acadica
  T. spini of Europe

Chrysophanus thoe
Calycopys cecrops
Heodes hypophleas
Uranotes melinus
Everes comyntas
Philotes sonorensis
Cyaniris ladon (pseudargiolus)
*Nomiades couperii**
Rusticus melissa
  *R. scudderii**

FAMILY RIODINIDAE

No riodinid larvae have been seen. The group is sometimes called a subfamily of Lycaenidae to which it is closely related. The head is said to be about half the diameter of the subonisciform body. In the absence of material it is impossible to be sure that the prolegs and crochets are of the peculiar form seen in Lycaenidae.

FAMILY LIBYTHEIDAE

American larvae of this family are not known to me, but the following characters, for which Edwards is the authority, are duplicated in *Libythea celtis* of Europe.

Hypatus bachmani. Body cylindrical, somewhat thickened in region of last two thoracic segments; dorsum of last two abdominal segments curved abruptly ventrad; each segment divided into four or five annulets; numerous secondary setae present, a group at the base of each leg and one on the first annulet of each segment, borne on chalazae.

In addition, *L. celtis* has the head covered with secondary setae, the second, third, and fourth ocelli on papillae, the other ocelli reduced, and the crochets arranged in a pseudocircle. The labrum is shallowly concave at tip. The general structure and habits are similar to those of the Pieridae, but the presence of the lateral rudimentary crochets of the pseudocircle will distinguish them.

The larva of *Hypatus carinenta* seems to be unknown.

FAMILY LYMNADIDAE

Head about as large as prothorax, bilobed; labrum with a rounded emargination. Body bearing fleshy filaments in the subdorsal region (Fig. 92), at least on the mesothorax; not more than three pairs of these processes present in American species; coloration always consisting of transverse black and green stripes.

Anosia plexippus bears a pair of these filaments on the mesothorax and another pair on the eighth abdominal segment. There are three transverse black stripes on each segment. *A. berenice* bears filaments on the mesothorax and the second and eighth abdominal segments. The middle of each segment bears a wide double broken black band reaching over the dorsum to the end of each proleg.

Lycorea cleobaea is the only species of Lycorea north of Mexico. No specimens of the larvae are in the National Museum; but a related species, *L. atergatis* of southern Mexico, has fleshy filaments on the mesothorax only, and the black color on the abdomen covers the venter and the intersegmental incisions.

FAMILY ITHOMIIDAE

The larvae of the three North American species of these Nymphaloidea seem to be unknown. Wilhelm Müller (1886) describes in a brief way other species of the same genera but gives no very definite structural data. The only distinguishing characters mentioned are arrangements of the setae in the first larval instar. In later stages numerous secondary setae are present and sometimes small cornicula (''zipfel'') below the spiracle, but no other form of armature.

Family Heliconiidae

But one species of this large tropical group ranges into the United States. The larvae are all typical Nymphalidae in most particulars. The characters given are drawn from *Apostraphia charithonia* of Florida but they apply also to most of the known South American forms.

Head distinctly bilobed, bearing a long, slender scolus on each lobe; front not reaching half way to top of head; color green with ocelli located on a black spot and another pair of black spots on the epicranium near the union of the arms of the epicranial suture.

Prothorax smaller than head, bearing a dorsal shield; shield with one large seta but no scoli; mesothorax and metathorax each bearing a subdorsal pair of scoli and one on each side slightly above the spiracular level; no subspiracular scoli present on thorax, but several verrucae located at the base of each leg. Abdomen with three scoli present on each side on each segment, one subdorsal, one supraspiracular, and one subspiracular; no scoli on dorsomeson; small chalaza or scolus present on abdominal segments 1, 2, 7, and 8, in line with prolegs in the position of the Pi group and another very small one in the position of sigma; scoli all very long and slender, nearly as long as body is wide; secondary setae minute or absent above level of prolegs, small on ventral surface. Prolegs all present and well developed; crochets biordinal or triordinal, arranged in a mesoseries.

The above description applies equally well in almost every particular to Agraulis of the Nymphalidae, but in that genus the scoli are not quite so long and slender. The shape of the head offers the most convenient means of differentiating the two genera, altho the difference is hard to describe. In the Heliconiidae the head scoli are located back of the plane of the front and are not borne on conical projections of the head. The scoli of Agraulis are borne on prominent conical projections which gradually merge into the scoli and which extend cephalodorsad so that the bases of the scoli are somewhat cephalad of the plane of the front.

Family Agapetidae

The larvae of the satyrs differ from other Nymphaloidea in several particulars and their external characters do not indicate a very close relationship. All their relatives except Anaea and Hypatus have an external armature consisting of scoli or fleshy filaments. On the other hand none but the Agapetidae have a bifurcate suranal plate.

Head as large as, or larger than, prothorax, which usually forms a constricted neck; surface rugose or tuberculated; shape varying from rounded above to bilobed or horned; labrum usually deeply emarginate; ocelli in most or all species with the third ocellus borne on an elevated tubercle and very much larger than the others. Body with numerous, well developed, lenticle-like papillae bearing small secondary setae; segments divided into annulets usually six in number; suranal plate bifurcate, bearing a pair of very rugose conical projections (Fig. 84). Prolegs bearing a mesoseries of uniordinal, biordinal, or triordinal crochets.

Genera of Agapetidae:

a. Head rounded above, not bearing conspicuous scoli, not with laterodorsal angles.
  b. Caudal processes widely separated, as far apart as long, parallel (Fig. 84). *Cercyonis*
  bb. Caudal processes almost contiguous at base, divergent.
    c. Mediodorsal and lateral stripes conspicuous. *Oeneis*
    cc. Mediodorsal and lateral stripes indistinct. *Coenonympha*
aa. Head bearing a pair of conspicuous dorsal prominences, sometimes reduced to sharp laterodorsal angles.
  b. Dorsal prominence about as long as head is wide.
    c. Head, including prominences, about once and a half as high as wide. *Enodia*
    cc. Head, including prominences, about twice as high as wide. *Satyrodes*
  bb. Dorsal prominences reduced to low knobs.
    c. Larger papillae of head few and sparse. *Neonympha*
    cc. Larger papillae of head closely placed. *Cissia*

The discussion and key are based on the following species; those not seen by the writer but described by Scudder are marked with an asterisk (*):

*Cercyonis meadii, C. alope**
Oeneis chryxus, O. jutta, O. norna*
Coenonympha typhon, C. elko
Enodia portlandia
*Satyrodes canthus**
*Neonympha phocion**
Cissia eurytus, C. sosybius**

Family Nymphalidae

Even when limited by the removal of the other Nymphaloidea, this family is a large and varied group. Scudder divides it into five tribes which are distinct in all stages; and these tribes are retained here as subfamilies. All of these species possess scoli, either on the head or body, except some of the Apaturinae, especially Anaea. This distinguishes them from all other butterfly larvae.

The separation from the Saturnioidea is more difficult. The arrangement of the scoli is apparently the same in the two families but is modified in different ways. In no nymphalids are mediodorsal scoli limited to segments 8 and 9 when they are present at all. The genera in which they are absent from the dorsomeson and in which the head scoli are also absent are Euptoieta, Speyeria and Anaea. The first is made conspicuous by the great development of the subdorsal scoli on the prothorax, and the last by the very large head; but no way of separating the species of Speyeria from those of Saturnia is known to me. Unfortunately no specimens of Speyeria have been available and I am compelled to rely upon Edwards' description. It is probable that the head of the saturnian is much smaller, that the crochets are more regularly biordinal, and that the anal prolegs are much larger than in Speyeria.

The work of Wilhelm Müller (1886) on this family is a classic. It is particularly notable as being the earliest scientific study of all the stages of the larvae of any group. His demonstration of the fact that the scoli have no relation to the primary setae is conclusive and is the reason for the omission here of the nomenclature used in other parts of the paper. Instead, terms are used denoting position, especially the following: mediodorsal, subdorsal, supraspiracular, subspiracular, and subventral. Their meaning is obvious and they answer as well as symbols in cases where there is but one transverse row of scoli, or other form of armature, to the segment, as in this group.

Subfamilies of Nymphalidae:

a. Scoli always present, usually subequal in size, never five times as long on mesothorax as on abdominal segments 1, 3, 5, and 6.
  b. Mediodorsal scoli never present on abdominal segments; head rarely bearing numerous secondary setae. ARGYNNINAE
  bb. Mediodorsal scoli present on at least a few abdominal segments; head usually bearing numerous secondary setae.
    c. Abdomen bearing a pair of scoli at base of each proleg similar to dorsal scoli in shape, but smaller; lateral setae of all scoli slender, closely placed; two mediodorsal scoli on segment 8 or one each on segments 8 and 9. MELITAEINAE
    cc. Abdomen bearing a single scolus or none at the base of each proleg; when present, shorter than other scoli; lateral setae of dorsal scoli stout, sparse (Fig. 74); only one mediodorsal scolus on segment 8, none on segment 9 (Fig. 112). VANESSINAE

aa. Scoli often wanting, when present ten times as long on mesothorax as on abdominal segments 1, 3, 5 or 6.
  b. Mesothorax bearing scoli about as long as body is wide. NYMPHALINAE
  bb. Mesothorax without scoli. APATURINAE

Genera of Argynninae:

a. Abdominal scoli over half as long as segments.
  b. Subdorsal prothoracic scoli twice as long as those of abdomen, clavate; head bigibbous, rounded. *Euptoieta*
  bb. Subdorsal prothoracic scoli smaller than those of abdomen, not clavate.
    c. Head armed above with long scoli or short, pointed prominences; abdominal scoli not longer than those of thorax.
      d. Scoli of head long, spine-like; subdorsal pair of prothorax rudimentary. *Agraulis*
      dd. Scoli of head short, not spine-like; subdorsal pair of prothorax about as long as those of abdomen. *Argynnis*
    cc. Head rounded above, bigibbous, not armed with scoli or pointed prominences; abdominal scoli longer than those of thorax. *Speyeria*
aa. Abdominal scoli less than half as long as segments; head rounded, bigibbous; prothoracic scoli sometimes long. *Brenthis*

Genera of Melitaeinae:

a. Subspiracular scoli present on all three thoracic segments.
  b. Mediodorsal scoli light in color, others black; body with numerous slender secondary setae. *Lemonias*
  bb. Mediodorsal scoli black, like the others; body with stout, sparse secondary setae. *Euphydryas*
aa. Subspiracular scolus present on mesothorax but absent or reduced to a single seta on metathorax.
  b. Dorsal scoli stout, sometimes verruca-like, about twice as high as broad. *Phyciodes*
  bb. Dorsal scoli slender, at least three times as high as broad.
    c. Dorsal abdominal scoli not as long as segments, subequal in length to those of metathorax.
      d. Dorsal scoli of mesothorax and metathorax subequal in size; body striped, not spotted.
        e. Supraspiracular scolus of segment 8 dorsad and only slightly cephalad of spiracle; body with conspicuous transverse stripes. *Cinclidia*
        ee. Supraspiracular scolus of segment 8 cephalad of top of

spiracle, much farther cephalad than subspiracular; stripes longitudinal. *Charidryas*

dd. Dorsal scoli of mesothorax at least one and a half times as long as those of metathorax; body closely spotted; each segment bearing a large red dorsal macula. *Chlosyne*

cc. Dorsal abdominal scoli much shorter than those of mesothorax and metathorax; supraspiracular scolus of abdominal segment 8 dorsad of spiracle; stripes longitudinal. *Thessalia*

Genera of Vanessinae:

a. Head bearing a pair of dorsal scoli.

b. Spinules of body scoli erect; subapical ones in a whorl (Fig. 74).

c. Mediodorsal scoli present on all abdominal segments; head scoli no higher than head is wide. *Polygonia*

cc. Mediodorsal scoli present only on abdominal segments 7 and 8; head scoli twice as high as head is wide. *Mestra*

bb. Spinules of body scoli appressed, not arranged in a whorl; head scoli not clavate.

c. Dorsal scoli of head low, strongly tapering, concolorous with head, indefinite at base; body scoli needle-like, with two or three principal spinules. *Eugonia*

cc. Dorsal scoli of head cylindrical, distinct at base, darker than dorsal part of head; body scoli cylindrical, rather stout, with numerous lateral spinules. *Junonia*

aa. Head rounded above, bigibbous, bearing chalazae but no scoli.

b. Mediodorsal scolus absent on abdominal segments 1 and 2, present on segments 4 to 8, usually also on segment 3. *Euvanessa*

bb. Mediodorsal scoli present on abdominal segment 2.

c. Mediodorsal scoli present on segments 1 to 8 inclusive. *Vanessa*

cc. Mediodorsal scolus absent from segment 1. *Aglais*

Genera of Nymphalinae:

a. Abdominal segments 3 and 8 bearing scoli as long as those of mesothorax. *Limenitis*

aa. Abdominal segments 3 and 8 without scoli or with small ones. *Basilarchia*

Genera of Apaturinae:

a. Head crowned by a pair of scoli; suranal plate bifurcate. *Chlorippe*

aa. Head crowned only by a few low tubercles; suranal plate entire. *Anaea*

The following species of the Nymphalidae have been examined by the writer and on them the preceding synopsis is based.

Argynninae
    Euptoieta claudia
    Agraulis vanillae
    Argynnis cybele
Melitaeinae
    Lemonias chalcedon
        L. macglashani
        L. baroni
        L. editha
    Euphydryas phaeton
    Phyciodes montana
    Cinclidia harrisii
    Charidryas nycteis
        C. ismeria
    Chlosyne lacinia
    Thessalia leanira
Vanessinae
    Polygonia interrogationis
        P. satyrus
        P. zephyrus
        P. comma
Vanessinae (continued)
    Mestra amymone
    Eugonia californica
    Junonia coenia
    Euvanessa antiopa
    Vanessa atalanta
        V. huntera
        V. cardui
        V. caryae
    Aglais milberti
Nymphalinae
    Limenitis bredowii var. *californica*
    Basilarchia archippus
        B. astyanax
Apaturinae
    Chlorippe clyton
        C. alicia
        C. celtis
    Anaea andria

Scudder has described and figured the following in addition to some of the above and their place in the synopsis is based on his descriptions.

Argynninae
    Argynnis aphrodite
        A. atlantis
    Speyeria idalia
    Brenthis myrina
        B. montinus
        B. bellona

FAMILY PIERIDAE

Altho closely related to Papilionidae, the larvae of Pieridae are of a generalized structure little resembling their more advanced relatives. They seem to be characterized principally by a *lack* of osmateria, fleshy filaments, cephalic or anal horns, or special developments of the prolegs. Chalazae, the only form of armature present, make some of the secondary setae much more conspicuous than others. The conspicuous setae are not the "primary" ones, as Forbes seems to have assumed; they are too numerous and not in the right locations.

Head about as large as prothorax, not retractile except in *Phoebis*, distinct from prothorax and with caudal half well developed; front extending about half way to top of head; labrum moderately emarginate; numerous secondary setae present, varying from minute to large and borne on papillae of various sizes; surface of head varying from nearly smooth to rugose and irregular. Body bearing numerous secondary setae, sometimes all similar, usually of widely different sizes and borne on chalazae varying from microscopic to conspicuous; segments divided into annulets, usually six in number, each annulet bearing either a single row of setae or a band nearly its full width. Prolegs present on segments 3, 4, 5, 6, and 10, all similar in size; crochets biordinal or triordinal, always arranged in a mesoseries.

The following synopsis includes six of the nine genera occurring north of Florida and east of Texas and the Rocky Mountains. No specimens of *Nathalis iole, Zerene caesonia,* or *Pyrisita mexicana* of the southern states have been available. Larvae of all of the northern species east of the Rockies have been examined except *Eurymus interior.*

Genera of Pieridae:

a. Setae of head borne on chalazae, those of front much smaller than those laterad of the epicranial suture.
  b. Head with many chalazae as high as tubercles on which ocelli are placed, about as conspicuous as those of thorax.
    c. Prothoracic legs at least half as long as mesothoracic. *Pontia*
    cc. Prothoracic legs much less than half as long as mesothoracic. *Callidryas*
  bb. Head with chalazae usually lower than ocellar tubercles; when a few are well developed they are not one-fourth as large as those of prothorax. *Synchloe*
aa. Setae of head usually not borne on chalazae, those of front always similar to those laterad of the epicranial suture; setae of body all minute and similar.
  b. Head about one-third as wide as abdomen, deeply retractile. *Phoebis*
  bb. Head at least half as wide as abdomen, scarcely retractile.
    c. Body setae not on chalazae or on very small ones. *Eurymus*
    cc. Body setae borne on distinct chalazae, higher than wide. *Eurema*

Pontia monuste and *Pontia protodice* have many of the chalazae much larger than others, while *P. rapae* and *P. napi* (including var. *oleracea*) usually have all the chalazae small and subequal in size.

Neither of the two species of Callidryas have been available but the genus was placed in the table on the authority of Scudder's detailed description of *C. eubule.*

Synchloe (=Anthocharis) has several and various forms of larvae. In *S. genutia* some of the prothoracic chalazae are very large and those of the head are well developed, while in *S. sara* and *S. olympia* the setae of the head and prothorax are all small and borne on small chalazae.

The larva of *Phoebis argante* var. *maxima* Neum. is large with a small retractile head.

The bright green larva of *Eurymus philodice* is well known in the eastern half of the United States. It has a pair of distinct lateral lines and a black spot below the line on each segment. *E. eurytheme* which ranges eastward to some extent from its home in the Rocky Mountains has a similar larval stage except that the black spots are either indistinct or connected from one segment to another.

Eurema nicippe has the setae all about the same size. The larger chalazae of the head are larger than the ocelli. The larva of *E. euterpe (=lisa)* is less than three-fourths of an inch long and the chalazae of the head are all small.

FAMILY PAPILIONIDAE

Larvae of the Swallow-tail butterflies are, like the adults, beautifully decorated and outlined. No unpleasant spines or horns are present to discourage the observer and no discordant colors to offend him. The structure of all the species is so constant that it is necessary to have recourse to color in their separation, but all of the characters used are fixed and are seldom affected by alcoholic or other means of preservation.

Head smaller than prothorax, somewhat retractile, shorter in dorsal than in ventral portion; front not extending half way to top of head; labrum notched to about half its depth and bearing about thirty setae; ocelli six, subequal in size, fifth much closer to fourth than to sixth; secondary setae short. Body cylindrical, usually tapering rather abruptly toward the head and gradually toward the caudal end, usually widest in the region of the first abdominal segment; setae reduced or absent on body but numerous on prolegs; intersegmental incisions inconspicuous; prolegs short, bearing a mesoseries of triordinal crochets, sometimes with a lateral row, forming a pseudocircle; lateral crochets, when present, smaller than mesal, and biordinal. Osmaterium always present; when retracted its location is shown by a long transverse groove on the dorsum of the prothorax. In alcoholic specimens inserting the points of a small pair of forceps assures the observer of the nature of this groove and does no damage.

Scudder divides the family into six genera, each including but one or two species found in New England. Dyar's List discards three of them, uniting them under the name Papilio, but retains Laertias and Iphiclides. A study of the larvae of ten species of Dyar's Papilio, twice as many as Scudder had, shows the justification of Scudder's view, four distinct forms of larvae being found. As it would be very inconvenient to tabulate species of the family when using Papilio in the broader sense, the writer has returned to Scudder's arrangement. It might also be mentioned that the structure of the pupae upholds his position.

Genera of Papilionidae:

a. Body bearing several rows of fleshy filaments or filamentous processes. *Laertias*
aa. Body without processes of any kind, except osmateria.
  b. Crochets arranged in a pseudocircle; metathorax bearing an eyespot.
    c. Prothorax bearing a small transverse black shield; lateral line conspicuous; first abdominal segment bearing two black spots near its caudal margin but no continuous transverse black band. *Euphoeades*
    cc. Prothoracic shield indistinct, not black; lateral line inconspicuous; first abdominal segment bearing a continuous transverse black or yellow band near its caudal margin. *Jasoniades*
  bb. Crochets not arranged in a pseudocircle, no lateral crochets being present; metathorax not bearing an eyespot.
    c. Coloration not segmentally arranged; metathorax with a slight transverse dorsal swelling. *Heraclides*
    cc. Coloration segmentally arranged; metathorax without a dorsal swelling.
      d. Each abdominal segment bearing a transverse black band marked with or interrupted by circular yellow spots and usually bordered by two transverse green stripes; narrower black transverse intersegmental stripe also present in each incision. *Papilio*
      dd. Each abdominal segment bearing a series of five transverse black stripes. *Iphiclides*

Laertias philenor is distinguished from all other insect larvae by the possession of several pairs of fleshy filaments on each abdominal segment.

Euphoeades troïlus, in addition to the usual metathoracic eyespots, has a distinct pair on the first abdominal segment; those of the metathorax are separated by a distance on the dorsum subequal to the width of the outer circle of each eyespot. *E. palamedes* has an indistinct pair on the first abdominal segment and the metathoracic pair are separated by a distance three times as great as the width of the outer circle of each spot.

Jasoniades glaucus differs from other species of the genus Jasoniades in that the eyespot is single; that is, it is composed of a circle enclosing a smaller circle and a short rod, but is not associated with a smaller circle dorsad of the large one. The suture bounding the front is bluntly angulated at about the middle. In *J. daunus* the upper smaller figure of the double eyespot is rounded and the incisions between segments 5, 6, and 7 are marked with more or less distinct black lines. *J. eurymedon* and *J. rutulus* have the upper figure of the eyespot triangular and there are no black lines in the abdominal incisions, or else very faint ones. The former has the sides of the front arcuate while those of the latter are straight except for a very slight curve just where they unite.

Heraclides thoas (=cresphontes) is notable in having a conspicuous white mark covering segments 2, 3, and 4 and another on segments 7 and 8, while the rest of the body is a variegated reddish brown.

There remain for the genus Papilio the following species: *machaon, bairdii, zolicaon,* and *polyxenes,* all of which are very similar in coloration. At the same time there is such variation within species, especially as to the limits of these markings, that any suggestions as to their separation would be premature. *Papilio cresphontinus, americus,* and *indra* from the southern states and *P. brevicauda* from New England probably also belong here but they are so little known that their true position is somewhat uncertain.

Iphiclides ajax with its numerous transverse bands is quite distinct from all other members of the family.

Ithobalus. No specimens of the two species of this southern genus have been seen.

FAMILY PARNASSIIDAE

The parnassians seem to be an alpine or arctic group, for their American species are confined to the Rocky Mountains and Alaska. Their scarcity is to be regretted, for they retain many of the primitive characters of the Papilios. While the larvae have acquired osmateria, they still retain verrucae and conspicuous setae which are present only in the earlier larval stages of Papilionidae. As adults also, the venation is of the type found in Swallow-tails but the prolongations of the wings have not yet been developed. The following description is based on *Parnassius smintheus* of the Pacific States and it agrees in all important particulars with *P. apollo* of Europe. The only other species recorded south of Alaska is *P. clodius.*

Head rugose, black, about one-third the diameter of the abdomen, somewhat smaller than the prothorax; front small, wider than high, reaching about half way to top of head; labrum moderately emarginate, bearing only the six primary setae on each side; ocelli six, subequal in size, fifth much closer to fourth than to sixth; secondary setae of epicranium numerous but not long. Body cylindrical, scarcely tapering, covered with short, stout, secondary setae; thoracic segments with the verrucae of the Kappa and Pi groups, and sometimes those of Beta and Rho, distinct. Abdomen with Rho, kappa, eta, mu, and Pi forming distinct and separate verrucae; color black, except for several yellow subdorsal maculae on each segment; all setae black. Thoracic legs well developed, prolegs with a mesoseries of biordinal crochets extending more than half way round the planta; anal prolegs similar to ventral. Osmaterium present.

GLOSSARY

In the list of words on the following pages several new ones are included but most are words used here in a special sense. Smith's ''Glossary of Entomology'' and ''The Standard dictionary'' have proved most useful in its preparation altho no definitions from either are reproduced entire.

Adfrontal pieces, n. The narrow areas on the cephalic aspect of the head just laterad of the front. (Fig. 78.)

Anal prolegs, n. The prolegs of the last abdominal segment.

Anal segment, n. The tenth abdominal segment.

Annulet, n. One of the small rings into which a segment is divided by transverse constrictions.

Armature, n. The arrangement and form of all the setae and processes of the body wall.

Bigibbous, a. With a pair of large rounded dorsal swellings.

Biordinal, a. Said of crochets when they are arranged in a single series but are of at least two alternating lengths. (Fig. 106.)

Biserial, a. Said of crochets when they are arranged in two concentric rows. See multiserial.

Bisetose, a. Consisting of or bearing two setae; said of a group, such as Pi, or of a chalaza, pinaculum, etc.

Chaetotaxy, n. The arrangement of the setae of a particular insect or segment.

Chalaza, n. A small chitinized projection of cuticula bearing one seta or two to four setae on separate elevated prominences, between papillae and cornicula in size. (Fig. 90.)

Corniculum, n. A small horn-like process of cuticula, not associated with primary setae.

Coxa, n. The first segment of a thoracic leg.

Crochet, n. One of the series of chitinized, hook-like, cuticular structures usually arranged in rows or in a circle on the prolegs of lepidopterous larvae; also known as ''hooks''.

Epicranial suture, n. The suture separating the front from the rest of the epicranium, shaped like an inverted Y, with the front between the arms and the vertex on both sides of the stem. (Fig. 72.)

Epicranium, n. The sclerite which constitutes the greater part of the head capsule.

Fleshy filament, n. A flexible, attenuate process of the body wall, borne by some butterfly larvae. (Fig. 92.)

Front, n. The sclerite between the arms of the epicranial suture, usually triangular in shape.

Gibbous, a. With a large, rounded, dorsal hump.

Heteroideous, a. Said of crochets when a well developed series is flanked by a row of smaller crochets on each side, as in Arctiidae. (Fig. 100.)

Homoideous, a. Not heteroideous.

Homology, n. See Part One, p. 15.

Homotypy, n. See Part One, p. 15.

Horn, n. A stiff, pointed, unbranched, cuticular process.

Mesoseries, n. A band of crochets extending longitudinally on the mesal side of a proleg; when curved, varying from a quadrant to slightly more than a semicircle in extent. (Fig. 105.)

Moniliform, a. Possessing distinct, neck-like constrictions between successive segments, producing a resemblance to a string of beads, as in many leaf-miners.

Multiserial, a. Arranged in several concentric rows, as the crochets of Hepialus, Pseudanaphora, etc. (Figs. 94, 96.)

Multisetiferous, a. Bearing many setae.

Onisciform, a. Depressed and spindle-shaped, like an oniscid, as in some lycaenid larvae.

Osmaterium, n. An eversible gland producing an odor, as in Papilionidae and Liparidae.

Penellipse, n. A series of crochets more than a semicircle in extent and less than a complete circle. It may be either (a) lateral, covering at least the lateral half of the planta, as in Psychidae (Fig. 85); or (b) mesal, covering at least the mesal half of the proleg and interrupted laterally, as in Pyraustinae (Fig. 98).

Pinaculum, n. A small, flat, chitinized area bearing from one to four setae.

Plate, n. An extended chitinized area of the body wall, such as a shield; often multisetiferous.

Primary seta, n. A seta found on generalized larvae in all instars. When contrasted with ''secondary setae'' this term also applies to the few subprimary setae.

Proleg, n. A fleshy abdominal leg, said to be present when crochets are present even when there is no fleshy swelling.

Pseudocircle, n. An arrangement of crochets consisting of a well developed mesoseries and a row of small hooks on the lateral aspect of the proleg. (Fig. 97.)

Scolus, n. A spinose projection of the body wall, as in saturnian larvae. (Figs. 73, 74.)

Secondary setae, pl. n. Numerous setae having a general distribution and not limited to verrucae or other forms of tubercle. See page 23.

Seta, n. A chitinized, hair-like projection of cuticula arising from a single trichogen cell and surrounded at the base by a small cuticular ring.

Setiferous, a. Bearing one to many setae.

Shield, n. A chitinized plate covering the greater part of the dorsal half of a segment.

Sphingiform, a. Of the form of a sphingid caterpillar, having a cylindrical body, with setae very short or wanting and no other armature except a mediodorsal horn on the eighth abdominal segment.

Spinule, n. One of the short lateral branches of a scolus.

Stemapoda, pl. n. Elongated modifications of the anal prolegs in certain notodontid larvae.

Subprimary seta, n. A seta having a definite position in certain larvae but not present in the first instar of generalized groups. See Part One. For list of such setae, see pages 39, 40.

Suranal plate, n. A rather heavily chitinized area on the dorsum of the last abdominal segment. (Fig. 84.)

Triordinal, a. Said of crochets when they are of a single row but of three alternating lengths. (Fig. 98.)

Trisetose, a. Consisting of or bearing three setae; compare bisetose.

Tuft, n. A group of setae arising from a verruca.

Uniordinal, a. Said of crochets when they are arranged in a single row and are of a single length throughout or shorter toward the ends of the row; opposed to biordinal. (Figs. 101, 105.)

Uniserial, a. Said of crochets when they are arranged in a single row or series with their bases in line. (Figs. 101, 105, etc.)

Unisetose, a. Consisting of or bearing a single seta; compare bisetose.

Ventral prolegs, pl. n. Those prolegs ordinarily borne on segments 3, 4, 5, and 6; opposed to anal prolegs; hookless prolegs are sometimes also borne on segments 2 and 7 and these are also known as ventral.

Verricule, n. A dense tuft of upright setae, modified from a verruca or scolus. (Fig. 91.)

Verruca, n. A definitely bounded, somewhat elevated portion of the cuticle, bearing several to many setae. (Fig. 88.)

Vertical triangle, n. The thinly chitinized dorsal area bounded laterad by the caudal projections of the head capsule and caudad by the prothorax. (Fig. 72.)

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EXPLANATION OF PLATES

Plates I to VII and X consist entirely of setal maps. In these the top line of the diagram represents the dorsomeson and the bottom line the ventromeson. Thus the map shows the entire left half of the segment, the thoracic leg or the proleg, as the case may be, being indicated by an ellipse.

The body segments are numbered I, II, III, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10, the Roman numerals referring to the thorax and the Arabic to the abdomen. Care should be taken in using this in connection with the statements of other authors. For example, the head is counted as ''joint 1'', the prothorax as ''joint 2'', etc., in Dyar's descriptions. Dyar has also entirely failed to note segment 9 and thus, while segment 8 is his ''joint 12'', the anal segments is called ''joint 13''. In the setal maps the number of each segment is given in the lower left hand corner.

In all the figures, both of setal maps and other structures, the head is at the left.

The following is a list of all the setae. Each is indicated by a lower case Greek letter:

α alpha
β beta
γ gamma
δ delta
ϵ epsilon
η eta

θ theta
κ kappa
λ lambda (rare)
μ mu
ν nu
π pi

ρ rho
σ sigma
τ tau
ϕ phi
ω omega

Certain definite groups of setae are indicated by capital Greek letters. They are: Beta, B $(\alpha+\beta)$; Kappa, K $(\theta+\kappa+\eta)$ Rho, P $(\epsilon+\rho)$; Pi, Π ($\nu+\pi$ on thorax, $\nu+\pi+\tau$ on abdomen); Tau, T, some or all of the three setae, tau, phi, and omega, the first of which is, however, more closely associated with the Pi group on abdominal segments. Of the Kappa group, theta is usually absent.

The ocelli are numbered as in Fig. 70.

The numerals applied to the head setae are taken direct from Forbes (1910), who uses Dyar's system for them. In his paper will be found large numbers of drawings of head parts, and for that reason only a few have been figured here.

PLATE I—II

EXPLANATION OF PLATE I

Setal Maps. See page 147

Fig. 1. Hypothetical type showing the twelve primary setae. In addition three of the more usual subprimaries are dotted in. The spiracle is shown in both the prothoracic (a) and abdominal (b) positions.

Figs. 2, 3, 4. *Hepialus mustelinus,* Hepialidae, Jugatae. Prothorax, mesothorax, and third abdominal segment, first instar. Adapted from figures by Dyar (1895b).

Fig. 5. *Hepialus humuli.* Prothorax and mesothorax of mature larva.

Fig. 6. *Hepialus humuli.* Abdominal segments 1 to 3 of mature larva.

Fig. 7. *Pseudanaphora arcanella,* Acrolophidae, Tineoida. Prothorax and mesothorax of mature larva.

Fig. 8. *Pseudanaphora arcanella.* Abdominal segments 1 to 3 of mature larva.

EXPLANATION OF PLATE II

Setal Maps.

Fig. 9. Typical mesothorax of Frenatae, labeled with Greek letters.

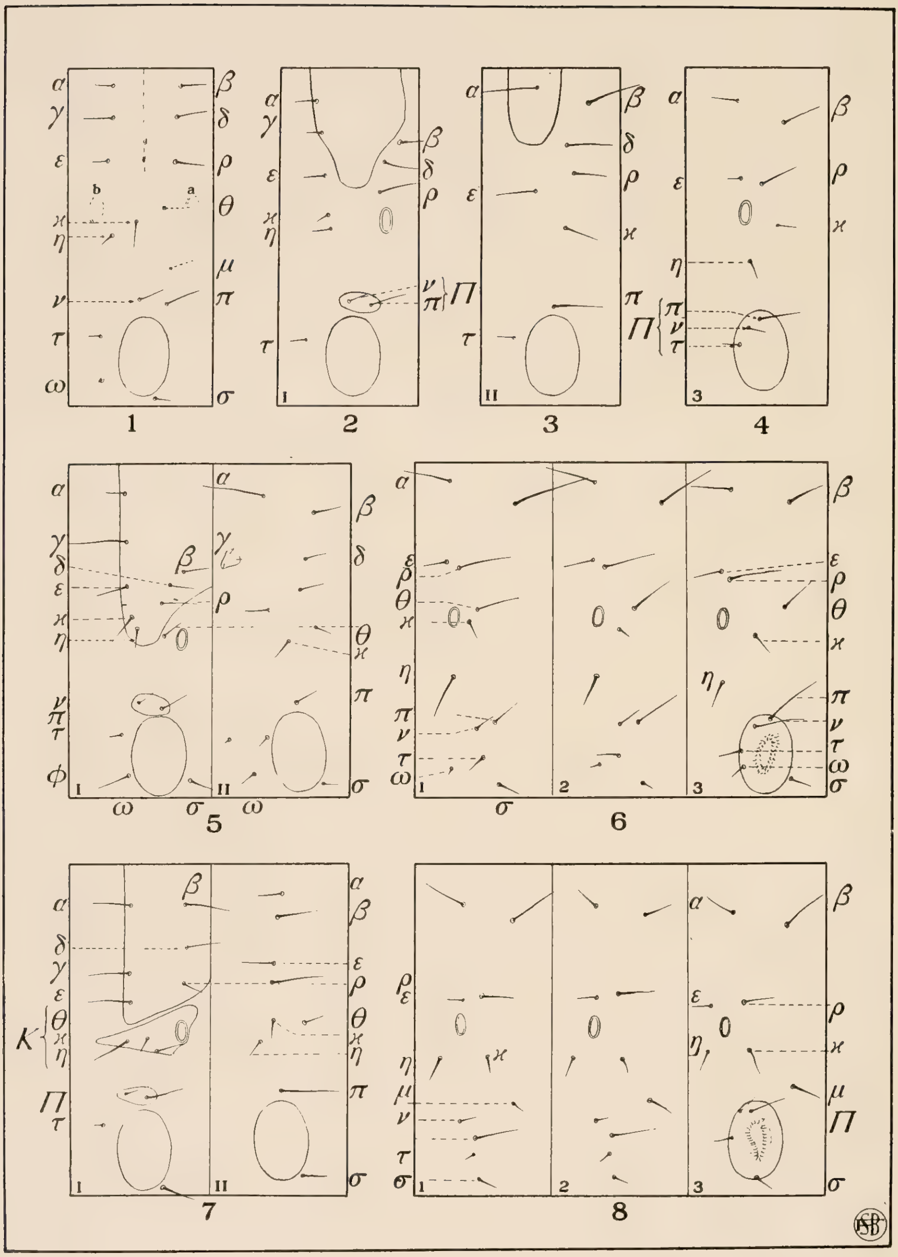
Fig. 10. Typical proleg-bearing abdominal segment of Frenatae, labeled with Greek letters.

Fib. 11. Typical mesothorax of Frenatae, labeled according to Dyar's system.

Fig. 12. Typical proleg-bearing abdominal segment of Frenatae, labeled according to Dyar's system.

Figs. 13, 14. *Hepialus humuli,* Hepialidae. Abdominal segments 6 to 10 of mature larva. (Tau and omega are transposed in Fig. 14.)

Figs. 15, 16. *Pseudanaphora arcanella,* Acrolophidae. Abdominal segments 6 to 10 of mature larva.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3 α β ρ ε ϰ η Π π ν τ
5
I II α β γ δ ε ρ ϰ η θ ν π τ ϕ ω σ
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1 2 3 α β ε ρ θ ϰ η π ν τ ω σ
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PLATE I

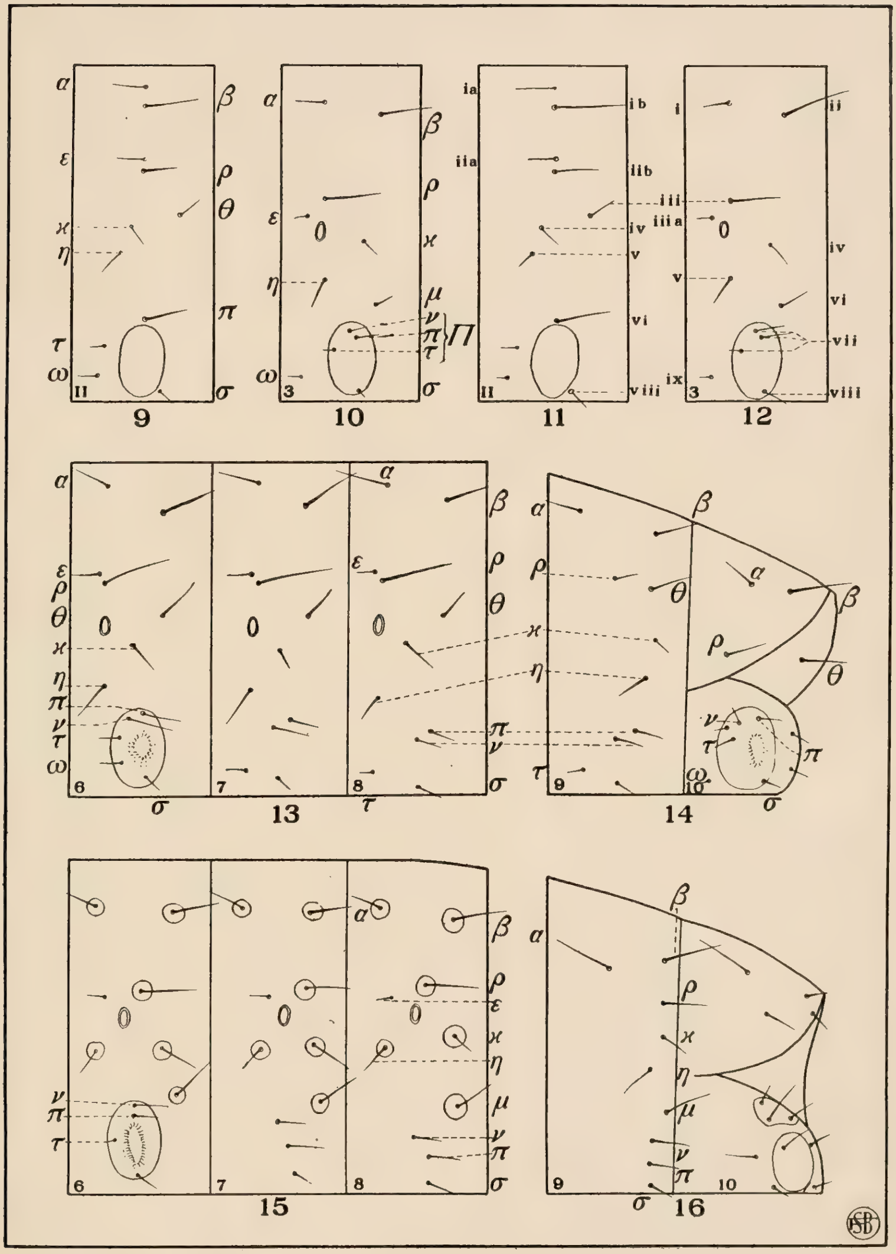
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PLATE II

PLATES III—IV

EXPLANATION OF PLATE III

Setal Maps.

Figs. 17, 18, 19, 20. *Feltia gladiaria,* Noctuidae. Prothorax, mesothorax, and first and second abdominal segments respectively; first instar.

Figs. 21, 22, 23, 24. *Feltia gladiaria,* Noctuidae. Same segments of the mature larva.

Figs. 25, 26, 27, 28. *Hyphantria cunea,* Arctiidae. Same segments of the mature larva.

EXPLANATION OF PLATE IV

Setal Maps.

Figs. 29, 30. *Feltia gladiaria,* Noctuidae. Abdominal segments 6 to 10 respectively; first instar.

Figs. 31, 32. *Feltia gladiaria,* Noctuidae. Abdominal segments 6 to 10 respectively; mature larva.

Figs. 33, 34. *Hyphantria cunea,* Arctiidae. Abdominal segments 6 to 10 respectively; mature larva.

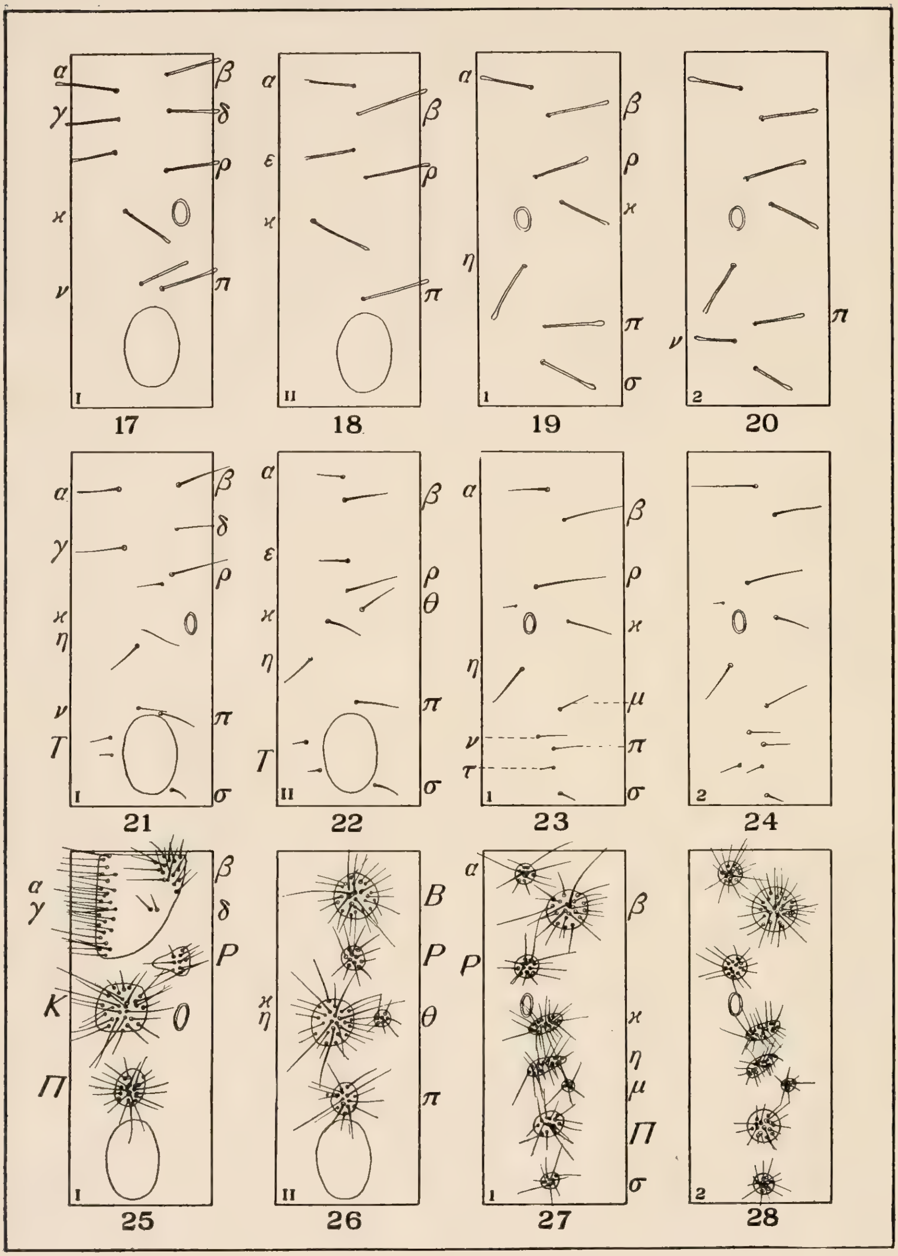
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PLATE III

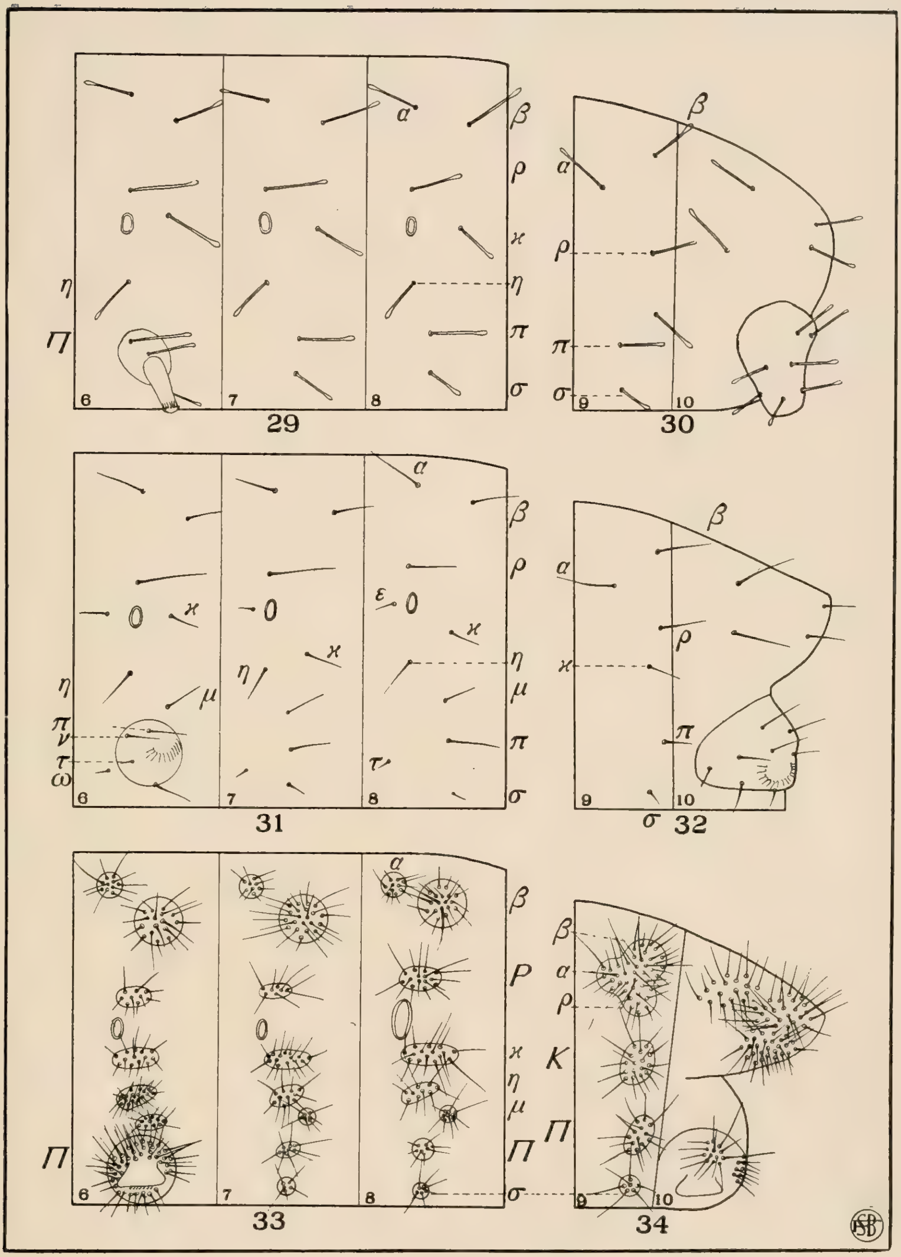
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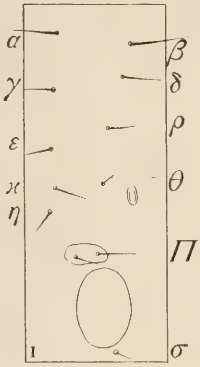
PLATE IV

PLATE V

EXPLANATION OF PLATE

SETAL MAPS.

Figs. 35, 36, 37, 38. *Atteva aurea,* Yponomeutidae. Prothorax, mesothorax, fourth and ninth abdominal segments respectively.
Figs. 39, 40, 41, 42. *Cydia pomonella,* Tortricidae. Same segments.
Figs. 43, 44, 45, 46. *Psorosina (Canarsia) hammondi,* Phycitinae, Pyralididae. Same segments.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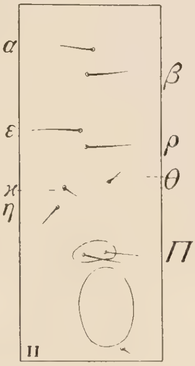
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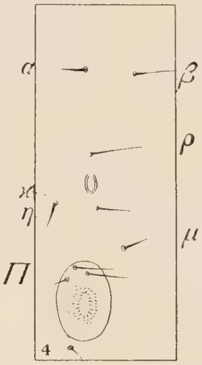

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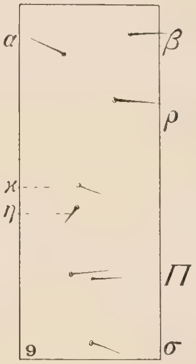

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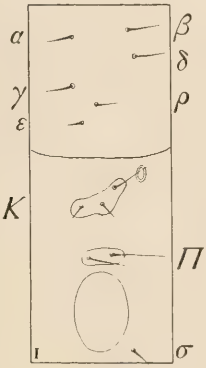
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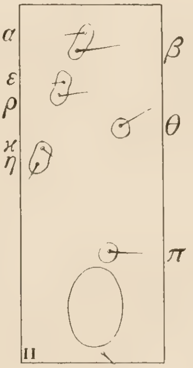
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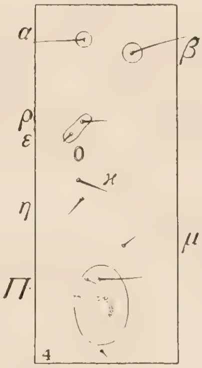

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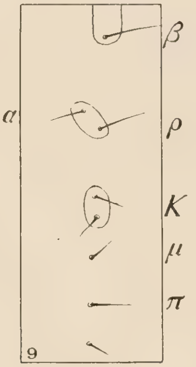

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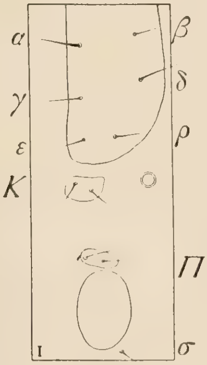
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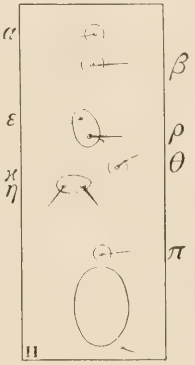
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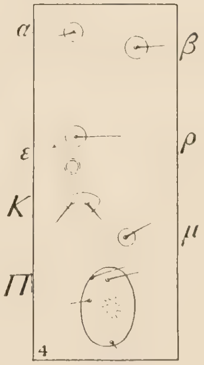

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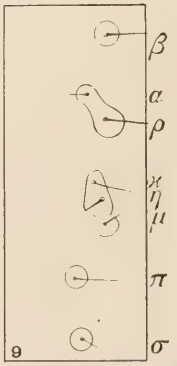

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PLATE V

PLATE VI

EXPLANATION OF PLATE

Setal Maps.

Fig. 47. Phycitinae, Pyralididae. Prothorax of an unidentified species showing arrangement of setae similar to that of Melitara.

Figs. 48, 49. *Loxostege similalis,* Pyraustinae, Pyralididae. Third and ninth abdominal segments respectively.

Fig. 50. *Galleria mellonella,* Galleriinae, Pyralididae. Mesothorax.

Figs. 51, 52, 53, 54. *Scardia fiskeella,* Tineidae. Prothorax, mesothorax, third and ninth abdominal segments respectively.

Fig. 55. *Thyris fenestrella,* Thyrididae. Ninth abdominal segment.

Fig. 56. *Gelechia* sp., Gelechiidae. Ninth abdominal segment.

Fig. 57. *Sanninoidea exitiosa,* Aegeriidae. Ninth abdominal segment.

Fig. 58. *Thyridopteryx ephemeraeformis,* Psychidae. Third abdominal segment.

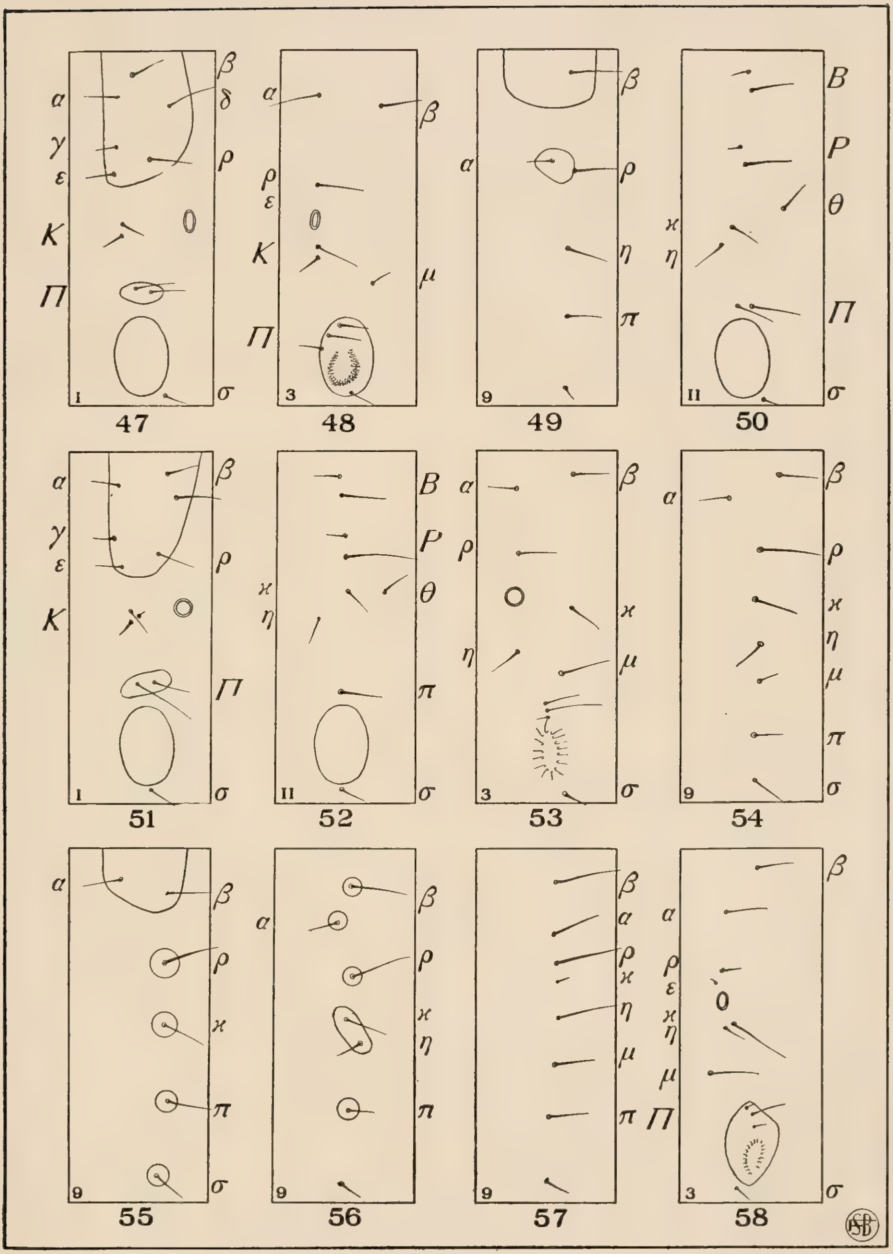
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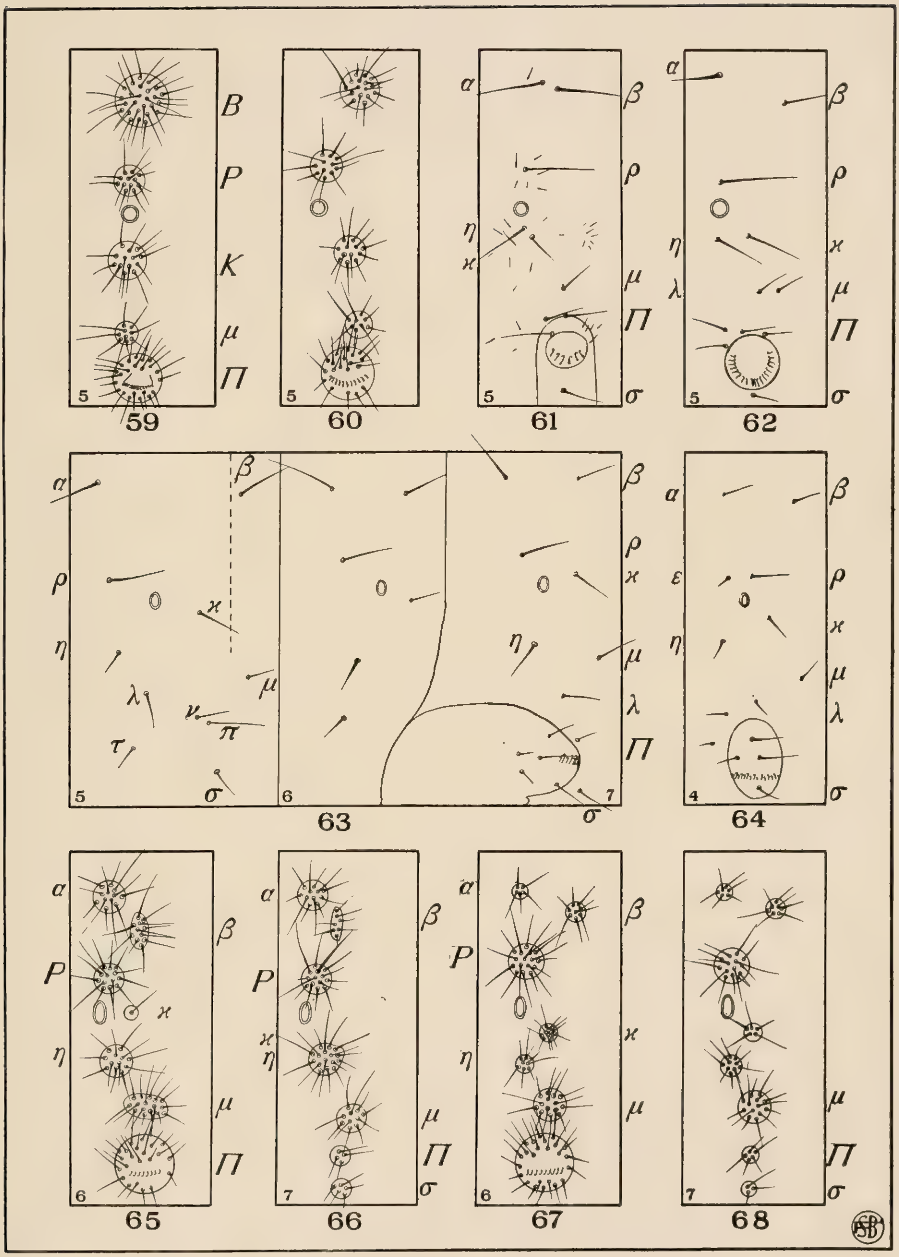
PLATE VI

PLATE VII

EXPLANATION OF PLATE

Setal Maps of Abdominal Segments.

Fig. 59. *Acoloithus falsarius,* Pyromorphidae. Segment 5.
Fig. 60. *Nola cristatula,* Nolidae. Segment 5.
Fig. 61. *Oxyptilus delavaricus,* Pterophoridae. Segment 5.
Fig. 62. *Callizzia inornata,* Epiplemidae. Segment 5.
Fig. 63. *Cleora pampinaria,* Geometridae. Segments 5, 6, 7.
Fig. 64. *Thyatira batis,* of Europe, Thyatiridae. Segment 4.
Figs. 65, 66. *Acronycta* sp., Noctuidae. Segments 6 and 7. Note fusion of verrucae kappa and eta on segment 7.
Figs. 67, 68. *Syntomis phegea,* of Europe, Syntomidae. Segments 6 and 7. Note that kappa is in same position on segment 7 as on segment 6.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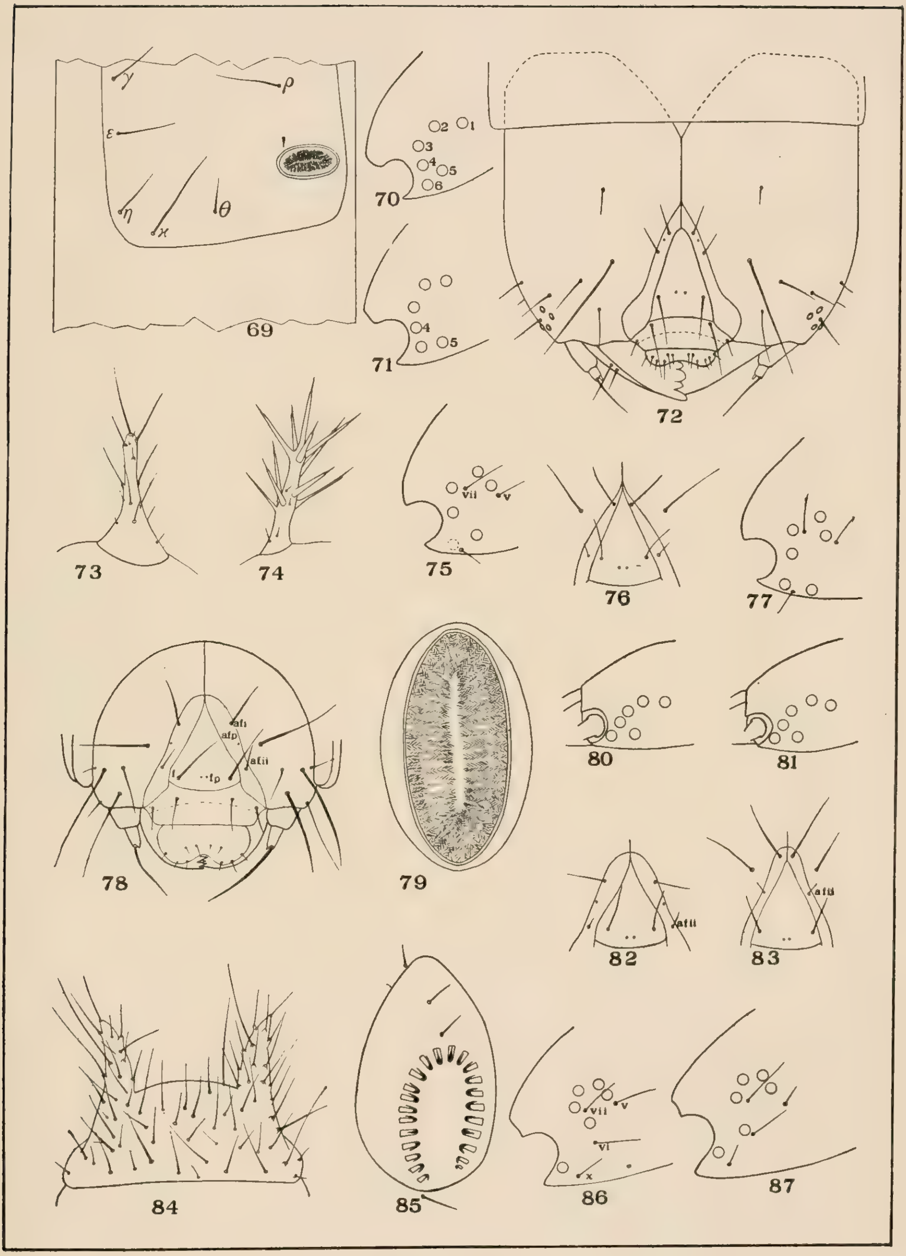
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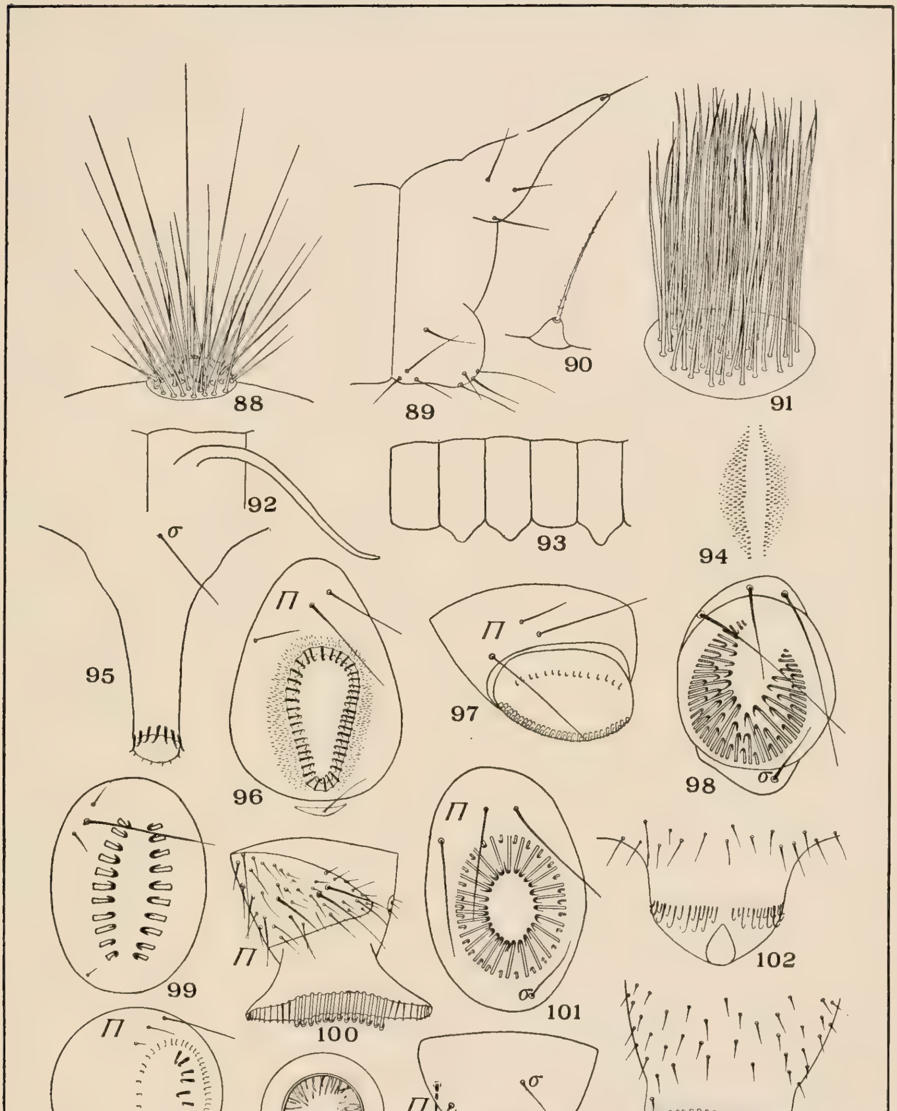
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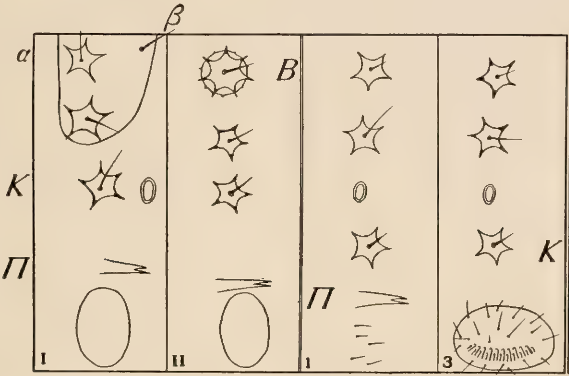
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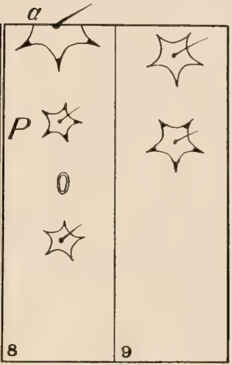

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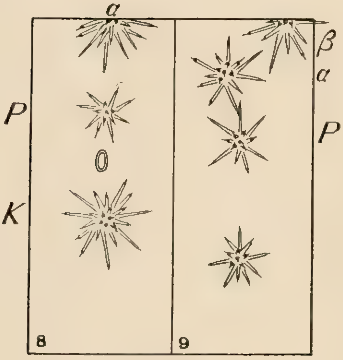

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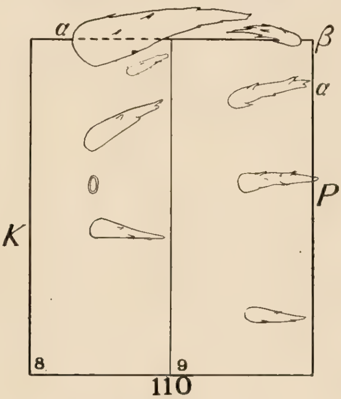

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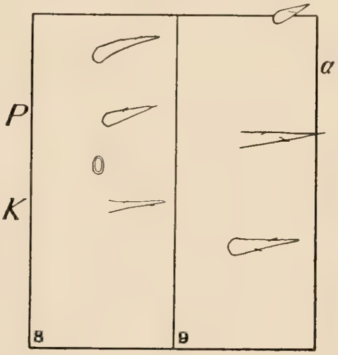

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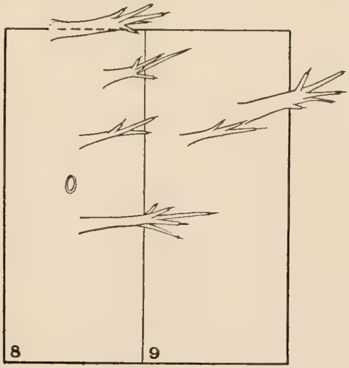

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ILLINOIS BIOLOGICAL MONOGRAPHS

Vol. II October, 1915 No. 2

EDITORIAL COMMITTEE

STEPHEN ALFRED FORBES WILLIAM TRELEASE
HENRY BALDWIN WARD

PUBLISHED UNDER THE
AUSPICES OF THE GRADUATE SCHOOL BY
THE UNIVERSITY OF ILLINOIS

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Distributed February 25, 1916

ON THE OSTEOLOGY OF SOME OF THE LORICATI

WITH FIVE PLATES

BY

JOHN EARL GUTBERLET

Contributions from the
Zoological Laboratory of the University of Illinois under the direction of
Henry B. Ward, No. 56

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INTRODUCTION

The suborder Loricati is characterized by the extension of the third suborbital bone across the cheek to the preopercle. This group has a wide range of variation and Gill has divided it into several families of which the rock fishes, or Scorpaenidae, are more generalized and the sculpins, or Cottidae, are the most specialized. The family Hexagrammidae comes between the two extremes, being more nearly related to the Scorpaenidae than to the Cottidae.

The purpose of this paper is to make a comparative study of the osteology of these forms in order to determine their relationship. Allen (1905) states that there are many points of resemblance to the Cottidae to be found in their osteology, visceral organs, and vascular systems, and that *Ophidon* is about as closely related to *Scorpionichthys*, a sculpin, as it is to *Hexagrammos,* and should be regarded as a type of a distinct family. For this study *Ophidon elongatus* and *Hexagrammos decagrammus* of the Hexagrammidae and *Scorpionichthys marmoratus* of the Cottidae were selected. The material was collected at Monterey Bay, California, by Mr. William F. Allen under whose direction the work was carried on at the Zoological Laboratory of the University of Illinois.

OPHIDON ELONGATUS

The Cranium

Except for a few ridges and grooves, the entire dorsal surface of the skull (Fig. 1) is flattened. On the anterior half there is a median rectangular groove which extends from between the posterior boundaries of the orbits to the median ridge of the ethmoid. Posterior to the groove the parietals form a ridge on either side, extending laterally and posteriorly, from the median line to the lateral edges of the epiotics. These ridges are continuations of the long rounded ridges of the frontals which form the sides of the rectangular grooves. The surface of the frontals, posterior to the orbits, is somewhat porous and has striations which pass caudad and mesad from the edge of the orbits toward the parietals.

The temporal fossa is formed by the pterotics, frontals, parietals and epiotics. It extends caudad from the latero-posterior edge of the frontal to the caudal end of the skull. In the anterior half it is comparatively shallow, but throughout the posterior half it has a depth of nearly one-third that of the skull. The fossa harbors some of the muscles of the shoulder girdle. The dilatator fossae (Fig. 5-6) are pits on the dorso-lateral edges of the skull, directly above the two articular facets of the hyomandibular. Anteriorly, each pit lies in the sphenotic and posteriorly in the pterotic. The pterotic forms the greater part of the roof of the pit while the most dorsal edge of the proötic forms a part of the ventral edge. Two foramina are present in the pit for the branches of the oticus vessels. The arch of the proötic which forms the bridge over the foramina for the fifth and seventh nerves, the jugular vein and the external carotids is conspicuous in *Ophidon.* It begins at the anterior central portion of the bone and extends dorsad to the ventral edge of the anterior articular facet of the hyomandibular on the sphenotic.

Vomer.—The vomer (Fig. 1) is the anterior bone of the skull and caps the cartilage from the ends of the ethmoid and the prefrontals. It possesses both dorsal and ventral processes. The dorsal and anterior one passes upward and posteriorly and articulates with the ethmoid and prefrontals. The ventral process forms a part of the ventral surface; it passes posteriorly and gradually tapers to a point in the parasphenoid. A V-shaped slit is present in the dorsal process and forms a trough-like cavity with the ventral process, allowing the cartilaginous portion of the ethmoid to pass into it. The anterior edge is broad V-shaped in the median line and rounded from the median portion laterad forming a large expansion at each side. Two kinds of teeth are present on the vomer; an inner row of large canine-shaped ones and an outer row of the villiform variety in which the teeth are irregularly arranged. Both kinds are slightly curved caudad and are placed in sockets. The maxilla and premaxillary both articulate just above the vomer and cover it entirely.

Ethmoid·—The anterior dorsal portion of the ethmoid (Fig. 1, 6, *eth*) is strongly keeled, while the posterior portion is concave longitudinally and ends between the frontals where it tapers to a point. There is a narrow median ridge on the keeled portion extending its full length with a V-shaped slit in the anterior end. The ventro-lateral depression of the anterior portion forms a cavity between it and the prefrontal, these parts forming the ventral and mesial osseous walls of the nasal pit. The longitudinal groove in the concave portion is formed by a dorso-lateral expansion on either side at its anterior end. From this point the groove passes caudad and continues as the rectangular groove between the ridges of the frontals. The sides of the posterior portion are concave from the point at which the lateral expansions extend out from the median line. On each side of the lateral concave surfaces there is a deep pit produced by several pores.

Prefrontal.—The paired prefrontals or ectethmoids Fig. 1, 6, *pfr*) are lateral to the ethmoid and anterior to the frontals. Each is a lateral expansion from the ethmoid and the frontals, having a broad base-like portion and a wing-like process extending from it which forms the anterior boundary of the orbit. The anterior portion is somewhat lower than the rest and appears as a shelf at the side of the ethmoid because of a depression on its anterior dorsal surface. This depression, together with a similar depression on the latero-ventral surface of the ethmoid forms a part of the bony wall of the nasal pit. The wing-like process is narrow antero-posteriorly but broad and flattened dorsoventrally. The end is rounded and forms a facet for articulation with the palatal and the first exorbital bone. A small ventral process on the wing meets a process from the palatine. From the base of the wing-like portion the bone flattens out antero-posteriorly as it extends ventromesad to its articulation with the parasphenoid. There is a foramen through the wing near its suture with the ethmoid through which the olfactory nerve and the orbito-nasal vein and artery to the nasal pit pass. Above the point where the prefrontal unites with the parasphenoid they come in contact with each other in the median line holding between them the ventral edge of the cartilaginous orbito-sphenoid which extends dorsad and caudad forming a partial partition between the orbits.

Frontal.—The paired frontals (Figs. 1, 6, *fr*) form the greater part of the dorsal surface of the cranium. At the anterior end of each there is a small groove produced by pores in the bone. The lateral edges of the posterior portion form the mesial boundaries of the orbits. The posterior portion broadens and forms the posterior and dorsal boundaries of the orbits. At this point the frontals are slightly rounded dorsad and the bone is somewhat porous, possessing several striations which start at the posterior boundary of the orbit and radiate caudad and mesad toward the median line to the parietal bones. The lateral edges of the posterior portion form the mesial border of the anterior part of the temporal fossa. At the lateral edge on the posterior border of the orbit the frontal unites with the sphenotic. Its lateral edge rests on the prefrontal and the mesial edge rests on the ethmoid. In the median line on the ventral surface there is a cartilaginous orbito-sphenoid bone, extending to the parasphenoid and forming a partial partition between the orbits. The ventral surface of the roof of the orbit is filled with large pores and two deep grooves which become deeper as they pass caudad into the deeper part of the frontal. The mesial edge of the inner groove forms a large flange which projects ventrad along the lateral edge of the brain case. The outer edge of this flange narrows down and, as it passes ventrad, it is drawn out to a thin process; this flange and the thin process clasp the small alisphenoid between them as in *Scorpaena* described by Allis. The ventral surface of the posterior portion is smooth and in connection with supra-occipital which forms a plate beneath the parietals and posterior part of the frontals forms the roof of the brain case.

Postfrontal.—The postfrontal (Fig. 1, *pfo*) is a small tube-like bone similar to the one described by Allis in *Scorpaena scorpus* except that it is without spines. It lies on the part of the dorsal surface of the sphenotic which is not covered by the frontal and pterotic. The tube extends from the lateral edge of the sphenotic caudo-mesad to the anterior end of the temporal fossa.

Sphenotic.—The sphenotics (Figs. 1, 6, *spo*) are located at the lateral margins of the cranium, just posterior to the orbits and, in conjunction with the lateral expansions of the frontals they form the posterior boundary of the orbit. The dorsal surface of each is nearly flat, except for a groove formed for the postfrontal bone which lies within it. It thus forms supports for the frontal, the postfrontal, and the pterotic. It forms the anterior, lateral, and ventral portions of the cranium. The anterior margin borders on the orbit and the ventro-lateral edge forms a facet for the articulation with the anterior head of the hyomandibular. Directly dorso-anterior to the facet is a roughened surface which serves for the attachment of one of the palatal muscles. Dorso-posterior to the facet is a depression, the dilatator fossa, the posterior part of the sphenotic forming the anterior part of the depression. Between the dorsal part of the sphenotic and the frontal, beneath the postfrontal, there is a small foramen which transmits one of the branches of the otic vessels. The sphenotic also forms a part of the internal brain case; the internal surface is smooth and has two depressions, separated by a thin partition of bone which extends mesad into the brain cavity.

Proötic.—The proötic (Fig. 6, *pro*) forms a large part of the lateral surface of the cranium. It is bounded dorsally by the sphenotic and pterotic, anteriorly by the alisphenoid and the dorso-lateral process of the parasphenoid, ventrally by the parasphenoid, and posteriorly by the basi-occipital and exoccipital. Mesially it articulates with the basisphenoid and the proötic of the opposite side. On the ventral surface it is overlapped by the lateral edges of the posterior portion of the parasphenoid. The proötics form the lateral walls of the brain case and also the roof and walls of the myodome. The brain cavity and the myodome are separated by a mesial longitudinal partition-like process which unites with a similar one from the opposite side in the median line. This partition begins at the basioccipital, which also forms the posterior part of the floor of the brain case, and extends dorso-cephalad until it reaches the processes which support the T-shaped basisphenoid, leaving a small wedge-shaped slit between the basisphenoid and the partition for the opening of the pituitary body from the brain case. Near the lateral wall, just posterior to the process which supports the basisphenoid, a small foramen for the sixth nerve preforates the partition. Between the proötic, alisphenoid, and the dorso-lateral process of the parasphenoid there is a large foramen through which the anterior cerebral vein, the ciliary nerve, and ciliary artery pass. On the front edge of the foramen and slightly mesad, at the base of the process supporting the basisphenoid, there is a second small foramen for the third nerve. On the lateral surface of the proötic is the proötic arcade, which is located slightly dorso-posterior to the foramen between the bones just described and directly ventral to the anterior articular facet for the hyomandibular on the sphenotic. This arcade partly shelters two foramina. The anterior and larger one is for the passage of the jugular vein, the external carotid artery, the fifth and part of the seventh nerves. The posterior one is for the hyomandibular part of the seventh nerve. There is another small foramen for the fourth nerve just anterior to the arcade. The arcade forms an arch through which the jugular vein and external carotid artery pass after they have passed through the foramen. On the inner surface the brain case is smooth with a large broad ridge, produced by the broad groove on the external surface, extending from near the middle just behind the arcade to the posterior end of the bone (where it unites by suture with the exoccipital and the ventral most edge of the pterotic) and continuing caudad as the ridge on the exoccipital. Directly ventral to the ridge on the internal surface, there is a deep depression or groove parallel to the ridge and extending the length of it bordering on the floor of the brain case. This groove continues caudad into the basioccipital where it finally forms a recess with the overhanging edge of the exoccipital. Directly beneath the arcade there is a flange-like process extending from the floor of the brain case to the dorsal edge of the bone where it unites with a similar process of the sphenotic. This flange-like process forms two recesses for parts of the anterior semicircular canal.

Alisphenoid.—The alisphenoids (Fig. 6, *als*) are small, irregular bones, ventral to the articulation of the sphenotic and frontal where they are held in place by the clasp of the ventral flange and slender ventro-mesal process of the frontal. Each also comes in contact, ventrad and caudad, with the parasphenoid and proötic. The outer surface is porous while the inner surface is smooth and forms the latero-anterior part of the brain case. A large foramen, postero-ventral to the alisphenoid, and between it and the proötic and the dorso-lateral process of the parasphenoid, allows the passage of the anterior cerebral vein, the ciliary artery, and the ciliary nerve. Allis ('09) found a small foramen for the anterior cerebral vein perforating the alisphenoid in *Scomber, Cottus, Trigla, Peristedion, Dactylopterus,* and *Scorpaena* and states that Allen (1905) did not describe it in *Ophidon.* I do not find a foramen perforating the alisphenoid in *Ophidon* nor in *Scorpionichthys.* The anterior cerebral vein, according to Allen (1905), passes through the foramen formed by the proötic, the dorso-lateral process of the parasphenoid, and the posterior edge of the alisphenoid.

Parasphenoid.—The parasphenoid (Fig. 6, *ps*) is the longest bone of the skull and forms the ventral surface of the entire length of the cranium with the exception of the process of the vomer which passes caudad into the parasphenoid. The anterior portion is almost perfectly straight on the ventral surface while the posterior portion is slightly curved upward and the edges of the bone turn up dorso-laterally, the entire length of the bone. In the middle portion the edge projects upward as a long process which extends dorso-laterally to the edge of the alisphenoid. Directly posterior to the process, in the angle between it and the proötic, is a foramen through for the internal carotid artery. The bone has a concave longitudinal groove the entire length of the dorsal surface which, in the anterior portion, is divided by a tall partition, extending from a point immediately anterior to the tall processes to the anterior end of the bone where it terminates in the ethmoid and the vomer. At the anterior end there is a V-shaped slit on the ventral edge for the postero-ventral process of the vomer. The posterior end also has a V-shaped slit extending cephalad, forming the posterior opening of the myodome. The dorsal surface of the posterior portion forms a part of the floor of the myodome, between the proötics and the two tall dorso-lateral processes of the bone itself. This portion also forms a support for the proötics and the basioccipital.

Basisphenoid.—The basisphenoid (Fig. 6, *bs*) is a T-shaped bone forming the anterior part of the roof of the myodome, being attached to the processes extending mesad from the proötic, just postero-ventrad to the alisphenoid. The pedicle is curved ventro-cephalad to the parasphenoid where it is united to it by a bulb of cartilage. It is laterally flattened and the rest of the bone between the proötic processes is dorsally flattened but rounded ventrally and slightly curved cephalad at the point where the pedicle process projects.

Pterotic.—The pterotics (Figs. 1, 6, *pto*) form the lateral edges of the dorsal surface of the skull, posterior to the sphenotics and the postfrontals, and also the lateral borders of the temporal fossa. On the dorsal edge of such there is a narrow ridge extending from the anterior end to beyond the middle from which the surface gradually slopes to the lateral edge of the skull. A foramen for a lateral line canal occurs at the posterior end; the whole surface being more or less perforated. The lateral surface of the pterotic is bounded cephalad by the sphenotic and the proötic and ventrally by the proötic, exoccipital, and opisthotic. At the anterior end of the bone there is a depression which forms the posterior edge of the dilatator fossa and immediately posterior and slightly dorsal to the fossa is a facet for the articulation of the posterior head of the hyomandibular. Posterior to the facet is a broad shallow groove, the dorsal edge forming the edge of the groove, extending to the posterior end of the bone, where it narrows as does the bone itself. Ventro-caudad to the facet are two or three, more or less developed ridges, extending from the lower edge of the facet to the ventro-posterior edge of the bone where it unites by suture with the opisthotic. The ventral edge of the bone curves sharply inward, thus forming a broad rounded ridge between the facet and the point where it unites with the proötic and the exoccipital. The antero-ventral edge of the facet forms a flange-like shelf beneath which there is a slight depression forming, together with a flange-like expansion of the proötic, a broad groove extending from that point antero-ventrad on to the proötic. The inner surface of the pterotic forms the dorso-posterior part of the lateral wall of the brain case, there being a large cavity passing latero-caudad from the main portion of the brain case, and lying ventro-mesad to the facet of the hyomandibular. This cavity harbors a part of the external semicircular canal.

Epiotic.—The epiotics (Fig. 1, *epo*) form a part of the dorsal surface of the cranium. The lateral surface of each forms the mesial boundary of the temporal fossa; its mesial edge forms the lateral border of the supra-temporal pocket. The bone is bounded laterally by the posterior process of the parietal and pterotic; ventrally and postero-ventrally by the exoccipital and mesially by the supra-occipital. It forms a tall ridge extending postero-laterad as far caudad as the pterotic and the opisthotic above the exoccipital, and nearly parallel to the pterotic. The supra-scapular lies on the dorsal surfaces at the caudal ends of the epiotic and pterotic, thus forming a roof at the posterior end of the temporal fossa. At the anterior end the bones are overlapped by the supra-occipital and the parietals. The internal surface forms the dorso-caudal wall of the brain case. These parts form posteriorly pockets for the posterior semicircular canals, directly above and in connection with the exoccipital.

Parietal.—The parietals (Fig. 1, *p*) form a part of the dorsal surface of the cranium, their lateral edges forming the mesial borders of the temporal fossa. Each is somewhat irregular in shape with its broadened end cephalad and a long slender process, extending caudad slightly dorsad and laterad on the epiotic ridge, which in this position projects over and forms a part of the roof of the temporal fossa. At the posterior end of the process there is a foramen, passing cephalad into the bone for one of the lateral line canals. The process forms a ridge and extends antero-mesad, uniting with a similar ridge from the opposite side in the median line. The dorsal surface of the ridge is porous and possesses several striations parallel with the ridge. At the anterior end the bone joins by suture with the frontal; it is supported laterally by the pterotic and mesially and ventrally by the epiotic and supra-occipital. In the suture between the parietal and supra-occipital on each side of the median line is a foramen for the ramus lateralis accessorius vessels. The inner surface of the bone lies largely on the dorsal surface of the supra-occipital, but lateral to the plate-like supra-occipital, which covers the greater part of the cranial cavity; the parietal forms a part of the dorsal surface of the cavity where it arches over the space between supra-occipital and pterotic.

Opisthotic.—The opisthotic (Fig. 6, *opo*) is a small plate-like bone, oval in outline, lying between the pterotic and the exoccipital. The antero-dorsal edge overlaps the postero-ventral edge of the pterotic and the ventral edge overlaps the exoccipital, thus forming the latero-caudal edge of the skull. It is drawn out caudad into a rounded process which projects beyond the exoccipital and even with the pterotic. The opisthotic forms the posterior lateral wall of the temporal fossa, from the point of its union with the pterotic on the mesial surface. The posterior end of the bone has a bulb-like appearance and is united by a cartilaginous ligament to the suprascapular.

Exoccipital.—The exoccipitals (Figs. 1, 6, 8, *eo*) are irregular bones which form a part of the lateral and of the posterior surface of the cranium and of the brain case. A well defined angle, ventral to the opisthotic, separates the lateral from the candal surfaces. That part which forms the porterior portion lies directly below the epiotic and a part of it forms the base of the epiotic ridge. The dorsal edge also borders on and forms the posterior edge of the floor of the temporal fossa. That part posterior to the angle extends backward and forms a rounded head, the occipital condyle, which looks caudad and slightly ventrad, articulating with an anterior process of the first vertebra. The two condyles are dorso-laterad to the basioccipital and laterad to the foramen magnum. Ventrad to the epiotic ridge and the temporal fossa, the bone extends caudad and mesad, uniting in the median line with its fellow of the opposite side; thus forming the roof of the medulla oblongata. It is overlapped in the median line by a ventro-posterior process of the supra-occipital. Slightly above the angle separating the posterior and lateral surfaces, there is a small depression or groove, dorso-cephalad to the condyle, extending upward to the posterior end of the temporal fossa. The lateral surface of the bone is irregular in shape and possesses a broad deep groove extending from slightly cephalad of the angle separating the lateral and posterior surfaces to about the middle of the proötic. At the posterior end of the groove there is the foramen for the vagus nerve and slightly anterior to this, another foramen for the glossopharyngeus nerve perforates the bone in the same groove. On the posterior, dorsal surface, anterior to the condyle, are two foramina for the passage of the occipital nerves. The internal surface forms part of the posterior and part of the lateral walls of the brain case and the dorsal wall of the medulla oblongata. The ventro-mesial edge, overlapping the basioccipital, forms a lateral recess with the groove of the basioccipital on each side of the cavum sinus imparis. Dorsal to this recess, a larger cavity which lies slightly dorso-cephalad to the vagus foramen, lodges the ampulla of the posterior semicircular canal. The exoccipital unites cephalad with the proötic, ventrad with the basioccipital, dorsad with the opisthotic and epiotic, and mesad with its fellow from the opposite side and the supraoccipital.

Supraoccipital.—The supraoccipital (Figs. 1, 8, *so*) forms the dorso-posterior portion of the skull, lying between the epiotics, with a process between the exoccipitals, and also beneath the parietals and the posterior part of the frontals, thus forming the roof of the brain case as well as a part of the posterior wall. Between the epiotics it has a deep groove, extending from the dorsal surface, postero-ventrad, almost to the foramen magnum, where it ends in a process between the exoccipitals. The groove, the supra-temporal pocket, is formed by a process on either side which overlaps the epiotics. On the dorsal surface it has a small longitudinal crest in the median line extending cephalad from the anterior end of the groove to the point where the bone is overlapped by the parietals. The inner surface forms the roof of the brain case as it has developed into a thin plate-like bone beneath the parietals and the posterior part of the frontals. It has a smooth surface with a ridge at the posterior end extending postero-ventrad from the dorsal surface toward the foramen magnum. Beneath the point of articulation with the parietals and frontals a small flange is developed on the ventral surface near the lateral margin which extends latero-cephalad, and unites with a similar flange from the sphenotic by a cartilaginous ligament. In the base of the flange is a foramen for the ramus lateralis accessorius vessel which passes over the supra-occipital between it and the parietal.

Basioccipital.—The basioccipital (Figs. 1, 6, 8, *bo*) forms the ventro-posterior end of the cranium, the posterior end of the myodome, and the posterior part of the floor of the brain cavity. On its dorsal surface (floor of the brain case) are two longitudinal grooves, one on each side of the median line, lying along the lateral walls of the bone and separated by a rounded ridge in the median line. These grooves are open throughout the anterior half but are covered in the posterior half by the edges of the exoccipitals which overlap into the brain cavity and with the groove form recesses on each side as it passes backwards on each side of the pit of the cavum sinus imparis, reaching almost to the conical, vertebra-like, depression on the posterior end. The cavum sinus imparis is a deep pit on the dorsal surface in the median line near the posterior end, only separated by a single thickness of bone from the conical, vertebra-like, depression. This pit lies on the surface of the median rounded ridge between the lateral grooves which form the recesses in connection with the overlapping mesial edges of the exoccipitals. As the cavum sinus imparis passes backward it gradually becomes deeper until it forms a saccular cavity at the posterior end. The ventral surface of the bone possesses a long groove the ventro-lateral edges of which almost form a circle in connection with the parasphenoid. This groove tapers gradually into a narrow tube which passes to the posterior end and opens to the exterior by a slit-like opening on the ventral surface. This tube forms the posterior portion of the myodome. On the lateral surface of the bone is a rounded ridge, arising at the dorso-anterior edge, where it is a continuation of a similar ridge from the proötic, and extending postero-ventrad nearly to the ventral surface of the bone. The posterior end is rounded, with a slight conical depression which forms the facet for the articulation with the first vertebra.

Myodome.—The myodome is a long funnel shaped cavity, formed by the basisphenoid, the two proötics, the parasphenoid, and the basioccipital. The funnel is triangular in outline, located between the two proötics and ventral to the basisphenoid, the pedicle of which bisects the anterior end of the cavity. It becomes narrow as it extends caudad into the basioccipital where it tapers to a tube and opens to the exterior by a slit on the ventral surface. There is an oval opening between the basisphenoid and the partition of the proötics for the pituitary body. Immediately posterior to this opening on the dorso-lateral surface of the myodome there is a pocket which extends upward toward the trigemino-facial chamber and is only separated from it by a thin partition. Here the myodome is widest and narrows rapidly caudad until it forms the tube. At the median ventral edges of proötics and basioccipital is a long slit-like opening, the hypophysial fenestra, covered by the parasphenoid, except at the posterior end where it opens to the exterior. The myodome contains the eye muscles, which are attached to the walls and roof of the cavity and pass cephalad into the orbit.

Orbit.—The orbits are formed by the prefrontals, frontals, sphenotics, and suborbitals. They are large in *Ophidon* and the two are separated by the partial partition of the orbitosphenoid which is cartilaginous at its anterior portion and membranous at the posterior. At the anterior end the partition comes in contact with the prefrontals in the median line and at the posterior end it comes in contact with the dorsal surface of the basisphenoid and the pedicle unites with the membrane at the point of contact with the parasphenoid. Dorsal to the basisphenoid the membranous partition divides, extends laterally and unites on each side with the ventro-mesial edge of the alisphenoid and the ventral processes of the frontal, thus forming the posterior wall of the orbit and the anterior wall of the brain cavity. Directly dorsal to the basisphenoid and slightly lateral to the median line there is an opening through the membrane for the passage of the optic nerve. Above the openings for the optic nerves in the median line against the dorsal wall there is an opening for the olfactory nerves which pass cephalad and divide, one passing on either side of the partition and through the foramina in the prefrontal into the nasal sac.

Brain Cavity.—The brain cavity in *Ophidon* is quite large and extends from the posterior end of the orbit, from which it is separated by the lateral partitions of the infraorbital membrane, to the posterior wall of the cranium. The cavity has a series of recesses on the dorso-lateral walls for parts of the brain and on the ventral surface there is a groove like cavity, the cavum sinus imparis, beneath the foramen magnum. On the floor of the brain case are two grooves which extend caudad along the lateral walls of the basioccipital, parallel to the cavum sinus imparis to the posterior end. The mesial edges of the exoccipitals overlap and form saccular recesses of these grooves. Above each saccular recess there is a cavity—the part of the labyrinth enclosing that portion of the posterior semicircular canal which is located in the exoccipital. Dorsal to this is a large recess in the epiotic which is for the rest of the posterior semicircular canal. Antero-lateral to this recess in the pterotic there is a large recess for the external semicircular canal, with two pits in the ventral surface for the ampulla of this canal. One of these pits is located in the proötic and the other in the pterotic. Anterior to this recess there is another for the anterior semi-circular canal. This one is divided into two parts by a flange-like partition which extends dorsocephalad from the floor of the cavity. The anterior part of the cavity lies in the proötic and lodges the ampulla, while the posterior lies in the sphenotic and lodges the body of the canal. Directly anterior to the anterior semicircular canal there is another shallow cavity—the trigemino-facial chamber—which lies nearly in the line with the pituitary opening between the basisphenoid and the proötics. The dorso-anterior end of the brain case is located between the ventral flanges of the frontals.

FACIAL BONES

Premaxillary.—The premaxillary (Fig 9) is a long curved bone bearing teeth. Its anterior end is thickened and bears two dorsal processes extending dorso-caudad, with a V-shaped slit between them. The anterior process is long, slender, and laterally flattened at the base and gradually becomes rounded distally until at its end, where it articulates with the ethmoid, it is antero-posteriorly flattened. The posterior process is broad and thick at the base and as it nears the end it makes a sharp curve and comes to a point at its anterior edge; on its anterior mesial surface it has a deep depression into which an angular process of the maxilla passes as it articulates with that bone. It is rounded on its dorso-lateral surface except at a point slightly posterior to the middle where it has broadened and flattened into a sharp edge; from this point it gradually tapers to a long slender point which extends on the lateral surface of the mandible. The anterior end of the bone, anterior to the processes, is rounded and thickened as it nears the median line where it unites with its fellow from the opposite side. Two kinds of teeth are present on the premaxillary, an inner row of canine-shaped teeth and from one to several irregular rows of the villiform type.

Maxillary.—The maxillary is a long curved bone without teeth, having a thick articular head and a flat expanded hind end. The former has a large articular facet which appears double on account of a V between its articular surfaces. The antero-mesial of these processes curves mesad and lies inside of the dorsal process of the premaxillary with which it articulates, directly dorsal to the dorsal limb of the vomer. The antero-lateral process is drawn out into a pointed projection lateral to the process of the premaxillary with which the other process articulates, and upon which the anterior ends of the nasal and palatine bones rest. At the apex of the V between the articular processes, the bone is rounded mesad at the point where it fits over the process of the premaxillary. The ventral edge of the first suborbital rests on the dorsal surface of the maxilla for some distance back from the anterior end. The posterior flattened and broadened end rests on the lateral edge of the mandible as it passes postero-ventrally from the anterior end.

Nasal.—The nasal is a small bone connecting the prefrontal, ethmoid, and the maxilla and forming the roof of the nasal pit. It is Y-shaped, with one edge of the broad end lying on a small process on the dorso-anterior edge of the prefrontal and the other on the antero-lateral process of the ethmoid. The pedicle extends cephalad and rests upon the maxilla, thus forming the roof of the nasal pit.

Suborbitals.—The suborbital bones, three in number, lie on the lateral surface of the skull. The anterior end of the series is firmly attached to the dorsal edges of the palatine and maxillary, also articulated with the prefrontal at its lateral facet. At the posterior end the third bone is attached to the preopercular, thus forming a bridge from the anterior to the posterior ends across the cheek; and also the ventral boundary of the orbit. The suborbitals are plate-like bones. The anterior bone is broad, somewhat oval in shape, lying on the surface of the maxillary for some distance from the anterior end. Caudad it is united with the second suborbital bone. The second bone is elongate in shape and about one-half as broad as the anterior one. This bone really forms the ventral boundary of the orbit. The third bone is the longest and passes from the edge of the orbit and is extended caudad, forming the suborbital stay. It is elongate, and is slightly broadened at the posterior end. Near the anterior end of this bone is a small postorbital, forming the posterior edge of the orbit and extending to the edge of the sphenotic. In younger specimens this is merely a cartilage but in more mature forms it becomes ossified. This is a small plate-like bone lying in the dermal tissue.

Palatine.—The palatine is an irregular bone composed of two portions, a broad plate and an anterior rod. The plate is posterior and is somewhat triangular with the apex pointing caudad. On the lateral surface it is smooth except for some small narrow ridges which extend postero-ventrad from the dorso-anterior end. There is a large facet on the dorsal edge for the articulation with the prefrontal and with an edge of the first suborbital. This facet has a deep pit which extends as a groove on the dorsal edge to the posterior end, and serves for the articulation of the mesapterygoid. The mesial edge of the facet is extended dorsally into a tall process which becomes attached to the ventral edge of the prefrontal. The mesial surface of the palatine is roughened by porous openings and bears a deep groove bounded by the dorso-mesial and the ventro-mesial edges of the bone extending from the anterior end of the posterior portion to the posterior end of the bone. Two kinds of teeth are present on the ventral surface which are like those on the vomer and premaxillary—an inner row of large teeth of the canine variety and outer row of small villiform type, more or less irregularly arranged. The anterior rod-shaped part of the bone is somewhat curved antero-ventro-laterally from the dorsal edge of the triangular portion, directly anterior to the articular facet of the prefrontal and the suborbital bone. This rod is somewhat flattened dorso-ventrally at the anterior end where it articulates by a ligament with the dorsal surface of the maxillary on the antero-lateral process of the head of that bone.

Mesapterygoid.—The mesapterygoid, the ectopterygoid of some authors, is a long, slender, curved bone which unites the palatine with the quadrate. The anterior end of the mesapterygoid lies in the groove on the dorsal edge of the palatine, from there it passes caudad for a distance, then it curves ventrally and articulates with the anterior edge of the quadrate. It is flattened laterally at the posterior and middle parts but at the anterior end it is flattened dorso-ventrally. There is a small groove on the ventral edge where it lies in a groove on the dorsal edge of the palatine. On the dorsal edge of the mesapterygoid there is a long slender groove for a membranous bone, the entopterygoid, which forms a part of the ventral boundary of the orbit. At the point where the bone curves ventrally there is a plate-like process on the dorsal edge which connects with the mesapterygoid and the entopterygoid. On the posterior edge the bone possesses a slight groove where it unites with the quadrate. The bone tapers to a point at its postero-ventral end.

Hyomandibular.—The hyomandibular is shaped like an arrow head with the shank extending from the ventral edge. The anterior end is drawn out into a thin, pointed, plate-like process. Slightly dorso-caudad to the pointed end is a thickened part which passes ventro-caudad across the middle of the head and also across the shank, thus forming an irregular cross with the shank. At the anterior end of the bar forming the cross is a facet, the anterior head of which articulates with the facet of the sphenotic directly above the proötic arcade. On the posterior end of the cross bar there is a facet for the articulation with the opercular. The shank passes upward through the body of the bone and forms a double facet, the posterior head of which articulates with the facet of the pterotic immediately posterior to the dilatator fossa. The dorso-caudad part of the posterior head articulates with a flange-like process dorso-caudad to the facet. The long shank extends ventrally and is united to the symplectic at its ventral end by a mass of cartilage. The metapterygoid articulates with the anterior process of the hyomandibular which is a thin membrane bone filling the space between the anterior bar of the cross and the shank. Likewise the spaces between the other bars are also filled with a thin sheet of membrane bone, thus leaving slight depressions between the bars. There is a deep pit on the mesial surface at the angle between the anterior bar and the shank, which gives rise to two canals. One passes ventrally into the bone and opens on the lateral surface of the shank just anterior to the ridge which bounds the groove for the articulation of the preopercular. This canal bears the truncus hyoideo-mandibularis facialis vessel. The other canal passes ventrad and caudad, dividing into two parts; one opens to the exterior at the dorsal edge of the groove for the articulation of the preopercular and between the opercular bar and the shank, the other opens at the hind edge of the bone, directly beneath the opercular bar. These two canals transmit branches of the nerve of the laterosensory canal which lies in the region of the opercular. Another small foramen, in the dorsal edge of the groove for the preopercular, transmits a part of the hyoid nerve between the hyomandibular and the preopercular.

Symplectic.—The symplectic is a small paddle-shaped bone with a broadened end and a long slender process. It articulates at its dorsal and broadened end with the shank of the hyomandibular by a long cartilaginous ligament. The bone for the most part lies in a triangular groove on the lateral surface of the quadrate with its long process penetrating the bone almost to its articulating facet for the mandible.

Metapterygoid.—The metapterygoid is a broad plate-like bone, more or less quadrant shaped with two plate-like processes. The quadrant-shaped part is the ventral portion of the bone with the round edge united by a cartilaginous ligament with the dorsal edge of the quadrate. Two processes extend from the dorsal edge of the quadrant. One of these is somewhat elongated and extends dorso-cephalad coming in contact with the anterior process of the hyomandibular. The other extends caudad from the dorso-posterior edge of the quadrant, and bears a V-shaped slit for the hyoid artery on its ventral edge. The posterior edge comes in contact with the anterior edge of the shank of the hyomandibular. Two small flanges, one on either surface of the anterior process, bound a groove on the dorsal edge which extends nearly the entire length of the process. The groove is for the union with the hyomandibular.

Quadrate.—The quadrate is a quadrant-shaped bone with the ventral point thickened and formed into a head for the articulation of the articular. The dorsal or rounded edge is broken near the posterior edge where the bone forms a deep groove on the inner surface for the articulation of the symplectic where it passes downward into the quadrate. There is a groove on the posterior edge extending almost the length of the bone for the contact with the preopercular. The anterior edge is somewhat roughened and possesses no groove where it articulates with the mesapterygoid. On the dorsal edge the quadrate unites by a cartilaginous ligament with the ventral edge of the metapterygoid and cephalad with the entopterygoid and mesapterygoid, caudad it unites with the preopercular and the symplectic.

Preopercular.—The preopercular (Fig. 4) is a long, flat, curved bone with three small barbs on its posterior side. A lateral line sensory canal runs throughout its length, opening near the edge of the ventral barb and at the dorsal tip of the bone. There are also other sensory canals in the bone with openings at various points. The outer surface is smooth except that it has a narrow ridge at its postero-lateral edge which is located slightly anterior to the spines. The notch or pit formed by the curve is filled with a thin wavy sheet of bone which slightly overlaps the caudal edge of the shank of the hyomandibular. Slightly dorso-anterior to the ridge is a small roughened area for the articulation of the suborbital stay.

Mandible.—The mandible is made up of three bones, the dentary, articular and the angular. A broad rounded ridge runs from slightly anterior to the head of the articular nearly to the anterior end of the dentary. On the inner surface of the dentary is a cavity within the bone corresponding to the ridge on the exterior; the articular has no cavity but a groove which corresponds to the ridge. In the bone beneath the ridge there is a latero-sensory canal which extends from the anterior end of the dentary to the posterior end of the articular. The dentary is a long bone with two long processes at the posterior end, forming a V-shaped angle which fits over the anterior process of the articular for its articulation with that bone. The lower surface is broadened by a mesial extension of a plate-like bone forming the ventral surface. Two kinds of teeth are present on the dentary, an inner row of the large canine type and several irregular rows of the villiform variety.

Articular.—The articular is united to the dentary by several bands where it fits into the V-shaped angle for the union of the two bones. This bone has a large facet for articulation with the quadrate. Here the bone is quite broad and gives off three processes. Slightly anterior to the facet it gives off a dorsal anterior process which unites with the dorsal process of the dentary by a cartilage. Immediately ventrad to this, and anterior to the facet, it gives off a long process, the anterior end of which fits into the V-shaped angle of the dentary. On the ventro-anterior edge it gives off the third process which fits over the ventral process of the dentary. There is a groove on the inner surface of the anterior and ventral processes and a deep pit on the antero-ventral edge of the facet. Ventro-posterior to the facet is located the angular bone which serves as an attachment for some of the mandibular muscles to the quadrate and also to the intraopercular.

SCORPIONICHTHYS MARMORATUS

THE CRANIUM

The skull (Figs. 2, 5) of *Scorpionichthys* differs from that of *Ophidon* only in a few points. The dorsal surface is somewhat more rounded and is covered with a granulated network. The temporal fossae are slightly different in shape and the orbits are smaller and more circular in outline, also the surface between them is narrower and concave. On the dorsal surface of the ethmoid the longitudinal groove, present in *Ophidon,* does not occur and a large erect process extending antero-laterally from the median line takes the place of the small ethmoid processes. There is a broad flange on the posterior end of the skull extending mesad from the caudal end of the epiotic ridge toward the median line, also the supra-occipital possesses a crest on the posterior surface extending from the dorsal edge to the end of the postero-ventral process. The anterior end of the temporal fossa is formed mainly by the edges of the granulated network of the parietals and pterotic. The parietal projects over the fossa for a distance as also does the epiotic which goes to make up a part of the mesial edge of the roof. Most of the roof is formed by the extra-scapular lying on the dorsal surfaces of the epiotic and pterotic across the fossa. In the dilatator fossa the sphenotic forms the greater part of the roof, in contrast to the condition in *Ophidon;* also there are no foramina in the fossa for the passage of the branches of the otic vessels.

The vomer (Figs. 2, 5 *v*) is relatively smaller than in *Ophidon* but has the same general shape except that the lateral expansions are not as long and the dorsal process is shorter. Only villiform teeth are present; they are numerous and irregularly arranged. The dorso-anterior surface, slightly lateral to the median line, possesses a small articular facet for the articulation with a similar facet on the mesial edge of the maxilla.

The ethmoid (Figs. 2, 5, *eth*) has no depression on its lateral surfaces for the nasal pit. A tall antero-lateral process forms a V-shaped crest in the median line, supporting the nasal bones which roof the pit.

The prefrontals (Figs. 2, 5, *pfr*) are relatively large, especially anteriorly; they lack depressions for the nasal pits. A thin flange extends ventro-caudad from the ventral surface of the lateral edge of the wing-like expansions to the mesial portion where it unites with the parasphenoid in the median line. On the lateral edge of the anterior portion, directly posterior to the vomer and anterior to the wing, there is a small facet for the articulation with the palatine.

The frontals (Figs. 2, 5, *fr*) are somewhat shorter than in *Ophidon* and the surface between the orbits is markedly concave. The frontals unite with the sphenotics in the usual position and form a part of the orbit. The surface directly posterior to the orbit is somewhat depressed and forms a ridge on the ventral surface in the posterior part of the orbit. On the dorsal surface of the posterior portion of the bone there is a granulated network arranged more or less in longitudinal ridges with an irregular groove in the median line bounded by granulated ridges. The ventral surface is comparatively smooth and the part within the orbit is not porous as in *Ophidon*. There is a single ventral flange-like process on each side of the median line forming a part of the anterior boundary of the brain case. At the caudal end the flange is thickened and unites with the alisphenoid. A ridge extends from this point laterad to the edge of the bone at the place where it unites with the sphenotic, forming a triangular pit between the ridge and the anterior edge of the latter bone. There is also a small depression anterior to the ridge between it and the flange. In some specimens the flange comes in contact with the dorso-lateral process of the parasphenoid on the anterior edge of the alisphenoid.

The ventro-posterior edge of the sphenotic (Figs. 2, 5, *spo*), in connection with the dorsal edge of the proötic dorsal to the arcade, forms a facet for the articulation with the anterior head of the hyomandibular. In *Scorpionichthys* the proötic forms nearly half of the facet while in *Ophidon* it forms only a very minor part of it. The sphenotic forms the greater part of the roof of the dilatator fossa, a condition slightly different from *Ophidon* where the pterotic forms the roof.

The pterotic (Figs. 2, 5, *pto*) forms only a small part of the dilitator fossa and has a granulated surface.

The alisphenoid (Fig. 5 *als*) is not porous and is not held between the two ventral processes of the frontal. It lacks a foramen for the passage of the cerebral vein such as Allis ('09) found in *Scorpaena* and others. It forms the dorsal edge of a large foramen which is otherwise bounded by the edges of the proötic and the parasphenoid process.

The basisphenoid and parasphenoid (Fig. 5, *ps*) are the same as in *Ophidon* except that in the parasphenoid there is a small partition between the two dorsal processes which separates the anterior and posterior portions.

The proötic (Figs. 2, 5, *pro*) possesses a flattened process on its dorsal edge; this lies directly ventral to the hyomandibular facets and causes the hyomandibular to extend laterally from the skull. The ventral surface of this process contains a rounded pit which extends dorsad, almost between the hyomandibular facets. On the dorso-anterior edge, immediately dorsal to the arcade, the bone forms a part of the facet for the anterior head of the hyomandibular. In other respects this bone is like that of *Ophidon* except that the foramen for the external carotid artery, the jugular vein, and parts of the fifth and seventh nerves are located in a pit slightly mesial to the arcade.

The epiotic (Figs. 2, 5, 7, *epo*) is flattened on the dorsal surface and extends caudad into a flattened process which forms a part of the dorsal surface of the cranium. On the meso-posterior edge a flange-like process from the posterior end of the bone extends meso-cephalad to the median line where it unites with a similar process on the supraoccipital. The lateral edges of the epiotics project slightly over the fossa and form a part of the roof.

The parietals (Figs. 2, 5, *p*) have a granulated surface like that of the frontal and pterotic. They lie on the dorsal surface of the supraoccipital and form only a small part of the roof of the brain case at the edges of the supraoccipital. The bones do not meet their whole length in the median line, but leave the supraoccipital exposed.

The supraoccipital (Figs. 2, 7, *so*) has a flange-like process on the posterior surface which is a continuation of that on the epiotic. The flanges of either side fuse in the median line where they come in contact with the crest which extends from the dorsal edge of the bone to the ventral edge of the process. Near the dorsal edge of the skull it forms a slight depression on the caudal surface in connection with the parietal.

The basioccipital (Figs. 2, 5, 7, *bo*) and exoccipitals (Figs. 2, 5, 7, *eo*) are as in *Ophidon,* except that in *Scorpionichthys* the condylar processes and the basioccipital are longer.

FACIAL BONES

The maxilla is shorter and more flattened throughout its entire length than in *Ophidon.* On its ventro-mesial edge is a small facet for articulation with a similar facet on the dorsal surface of the vomer.

The premaxillary (Fig. 10) is much shorter than in *Ophidon* but the dorsal processes are the same. Only villiform teeth are present which are numerous.

The palatine is similar in all respects except that the mesial process is larger than in *Ophidon,* and only villiform teeth are present.

The hyomandibular has a large flange-like process on the outer surface which extends ventro-posteriorly from the dorso-anterior angle formed by the irregular cross, to nearly the postero-ventral edge of the shank. The shank is broad and flattened throughout and unites with the preopercular, symplectic, and metapterygoid.

The preopercular (Fig. 3) bears two spines, one long and pointed and the other short and somewhat rounded, a condition not found in

Ophidon. The dorsal edge of the bone is drawn out into a long slender process which lies on the posterior edge of the shank of the hyomandibular.

The mandible is shorter than in *Ophidon.* There is no ridge on the lateral surface of the dentary nor is there a cavity within it; also there is no mesial process on the ventral edge. It possesses villiform teeth but there seems to be a modification of the teeth in the inner row. These are longer than the others and have assumed more or less of a canine shape, placing the *Scorpionichthys* and *Ophidon* closer together.

HEXAGRAMMOS DECAGRAMMUS

THE SKULL

The dorsal surface is smooth and more rounded than either *Ophidon* or *Scorpionichthys,* on account of the lateral extensions of the pterotic and proötic which makes a broad and flat rather than a deep temporal fossa. The supraoccipital is especially conspicuous as it separates the two parietals and comes to a spine-like point. On each side of the median line the parietals form narrow ridges which extend postero-laterally on the lateral edges of the epiotics and form the mesial edges of the roof of the temporal fossa. The dilatator fossae are shallow grooves in the sphenotic and pterotic bones. They lack foramina.

The vomer (Figs. 12, 13) in this species has a relatively longer dorsal process than either *Ophidon* or *Scorpionichthys.* There is no articular facet on the dorso-anterior edge for the maxilla. Only villiform teeth are present.

The ethmoid (Figs. 12, 13) is not grooved but slightly keeled. It has no depressions for the nasal pits and the antero-lateral processes for the support of the nasal bone are similar to those of *Ophidon.*

The prefrontals (Figs. 12, 13) have no depressions on the dorso-anterior edge for the nasal pits and have articular facets on the antero-lateral edges for the palatines as in *Scorpionichthys.*

The frontals have a smooth dorsal surface which is slightly grooved between the orbits. It is not porous on the ventral surface and possesses a single flange process as in *Scorpionichthys,* differing from *Ophidon* and *Scorpionichthys* in not uniting with the sphenotic to form the posterior border of the orbit. As in *Scorpionichthys,* the sphenotic, in connection with the proötic, forms the facet for the anterior head of the hyomandibular.

The pterotic is a thin flange-like bone extending postero-ventrally from the sphenotic, thus forming the ventro-lateral boundary of the temporal fossa.

On the proötic there is a lateral flange-like process ventral to the facets for the hyomandibular; this extends out laterad below the facet for some distance, as in *Scorpionichthys.* The proötic forms a large part of the anterior facet for the hyomandibular. No special peculiarities are shown in the arcade or the location of the foramina.

The parasphenoid has no partition between the lateral processes to separate the anterior and posterior portions and differs from *Ophidon* in that the ventral surface of the anterior portion bears a conspicuous ridge.

The epiotic ends posteriorly in two processes.

The condylar processes of the exoccipitals are relatively longer than in *Ophidon* but not as long as in *Scorpionichthys.*

FACIAL BONES

The premaxillary is relatively shorter than in *Scorpionichthys* and much shorter than in *Ophidon.* Villiform teeth are present but there is a modifification of these in the outer row, as they are much heavier and longer than those of the inner rows.

The maxilla has a flange on its dorsal surface where it comes in contact with the first suborbital bone. Posterior to this flange the bone is flattened.

There is a facet on the anterior mesial edge of the palatine where it comes in contact with the ethmoid. Only the villiform teeth are present. The shank of the hyomandibular forms nearly a rectangular cross with the bar which bears the facets for the anterior head and the opercular bone. This causes the shank, which extends ventrally and slightly posteriorly in *Ophidon,* and directly ventral in *Scorpionichthys,* to extend antero-ventrally in this form.

The metapterygoid has a short rounded anterior process and a groove, formed by lateral and mesial flanges, on the posterior edge for the shank of the hyomandibular and the hyoid artery.

There are no particular differences shown in the quadrate except that it is more anterior in this fish than in the other species described, a condition brought about by the position of the hyomandibular shank. The quadrate lies ventral to the anterior edge of the orbit while in *Ophidon* it lies ventral to the posterior edge and in *Scorpionichthys* it is ventral to the central portion of the orbit.

The preopercular lacks barbs and spines and has no grooves nor ridges. It lies postero-ventral on account of the shank of the hyomandibular and the position of the quadrate. On this account the posterior end of the suborbital stay is somewhat lower.

No lateral ridge is present on the mandible and no cavity within the dentary, nor is there a mesial flange on the ventral edge, as in *Ophidon.* The dentary is relatively much shorter than in *Ophidon* and somewhat shorter than in *Scorpionichthys.* Villiform teeth are present but there is a slight modification of those of the outer row. They are longer and much heavier than those of the inner rows.

SUMMARY

Since *Ophidon* and *Hexagrammos* belong to the same family, Hexagrammidae, one might expect something of a similarity in their osteology and also more marked differences between *Scorpionichthys,* belonging to the family Cottidae, and *Ophidon.* From a study of these forms I find that there are more differences between *Ophidon* and *Hexagrammos* than between *Ophidon* and *Scorpionichthys.*

Some of the differences between *Ophidon* and *Hexagrammos* are,—

1. The dorsal surface is more rounded in the latter.
2. The supraoccipital possesses a conspicuous spine-like crest in the median line which entirely separate the parietals in *Hexagrammos.*
3. Foramina are present in the dilatator fossa in *Ophidon* but absent from *Hexagrammos.*
4. In *Hexagrammos* there are no nasal pit depressions on the ethmoid and prefrontal. The ethmoid is but slightly keeled and the anterior portion of the prefrontal possesses a lateral facet.
5. In *Ophidon* the frontal is thick and porous, but in *Hexagrammos,* thin and smooth, with a single flange and a single groove on the ventral surface.
6. The sphenotic does not form part of the posterior edge of the orbit in *Hexagrammos.*
7. In *Ophidon* only a small part of the anterior hyomandibular facet is formed by the proötic, while in *Hexagrammos* this bone forms at least half of it. Also there is a conspicuous lateral proötic process below the hyomandibular facet in the latter genus.
8. In *Ophidon* the hyomandibular shank extends ventro-caudad while in *Hexagrammos* it extends ventro-cephalad, placing the quadrate further cephalad.
9. In *Hexagrammos* the preopercular spines and ridges found in *Ophidon* are absent, and the bone itself occupies a more ventral position.
10. Relatively, the mandible is twice as long in *Ophidon* as in *Hexagrammos* and the dentary possesses no lateral ridge or cavity, nor a mesial flange on the ventral surface.
11. A marked difference is found in the teeth in *Ophidon* and *Hexagrammos.* Both canine and villiform are found in the former but only the villiform in the latter.

Some of the likenesses between *Ophidon* and *Scorpionichthys* are,—

1. Dorsally, both skulls are flattened and have similar temporal fossae.

2. The sphenotic and the frontal bones form the posterior edge of the orbit.

3. The proötic arcade and the location of the formina are identical in both.

4. The alisphenoid and the parasphenoid are alike, with the exception of a small partition between the dorso-lateral processes of the parasphenoid in *Scorpionichthys*.

5. Except for the longer premaxillary in *Ophidon*, the maxilla and the premaxillary are alike in both species.

6. The pterygoids, symplectic, and quadrate are alike in every respect.

7. In *Ophidon*, canine and villiform teeth are present and only villiform in *Scorpionichthys*, but in the latter the inner row of mandibular teeth is better developed.

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EXPLANATION OF PLATES

Abbreviations

als	Alisphenoid	*pfo*	Postfrontal
bo	Basioccipital	*pfr*	Prefrontal
bs	Basisphenoid	*pro*	Prootic
eo	Ex-occipital	*ps*	Parasphenoid
epo	Epiotic	*pto*	Pterotic
eth	Ethmoid	*so*	Supra-occipital
fr	Frontal	*spo*	Sphenotic
opo	Opisthotic	*tf*	Temporal fossa
p	Parietal		

All figures are reproduced from original drawings made by the author from preparations.

PLATE I

EXPLANATION OF PLATE

Fig. 1. Dorsal view of skull of *Ophidon elongatus.* Natural size.

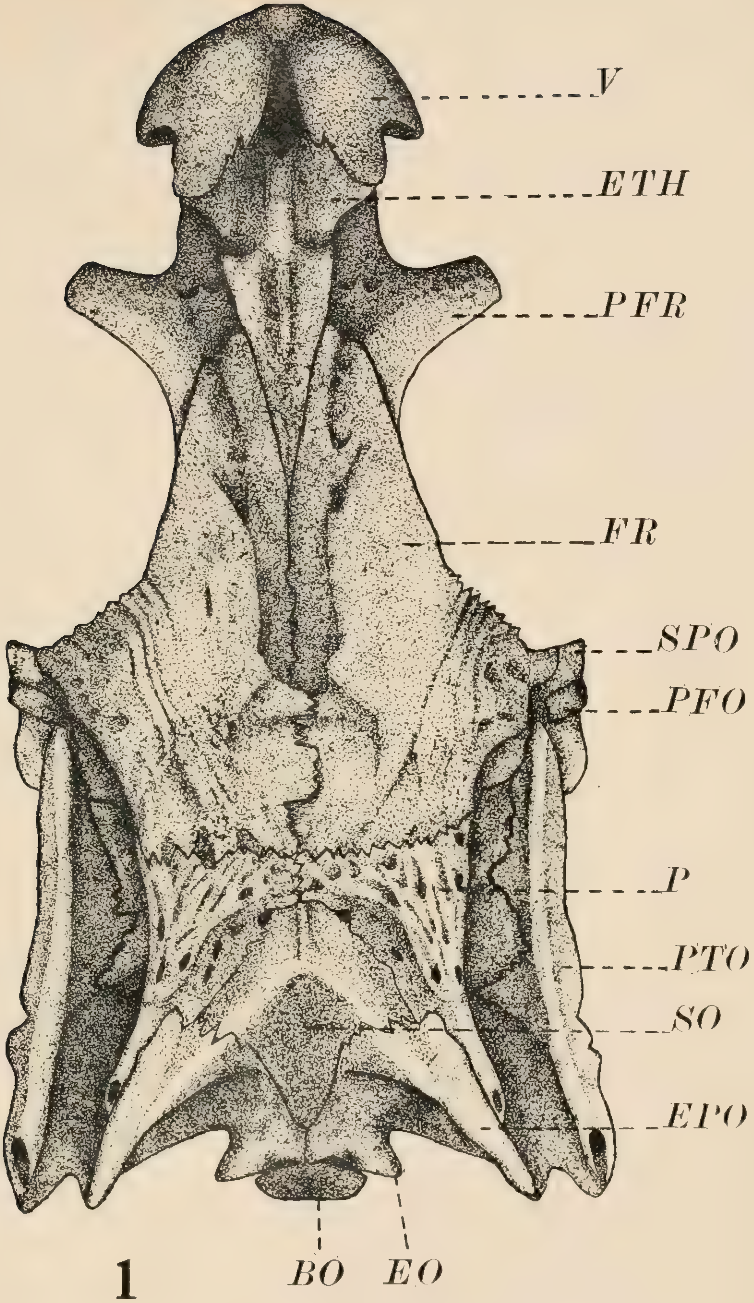
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PLATE I

PLATE II

EXPLANATION OF PLATE

Fig. 2. Dorsal view of skull of *Scorpionichthys marmoratus*. Natural size.

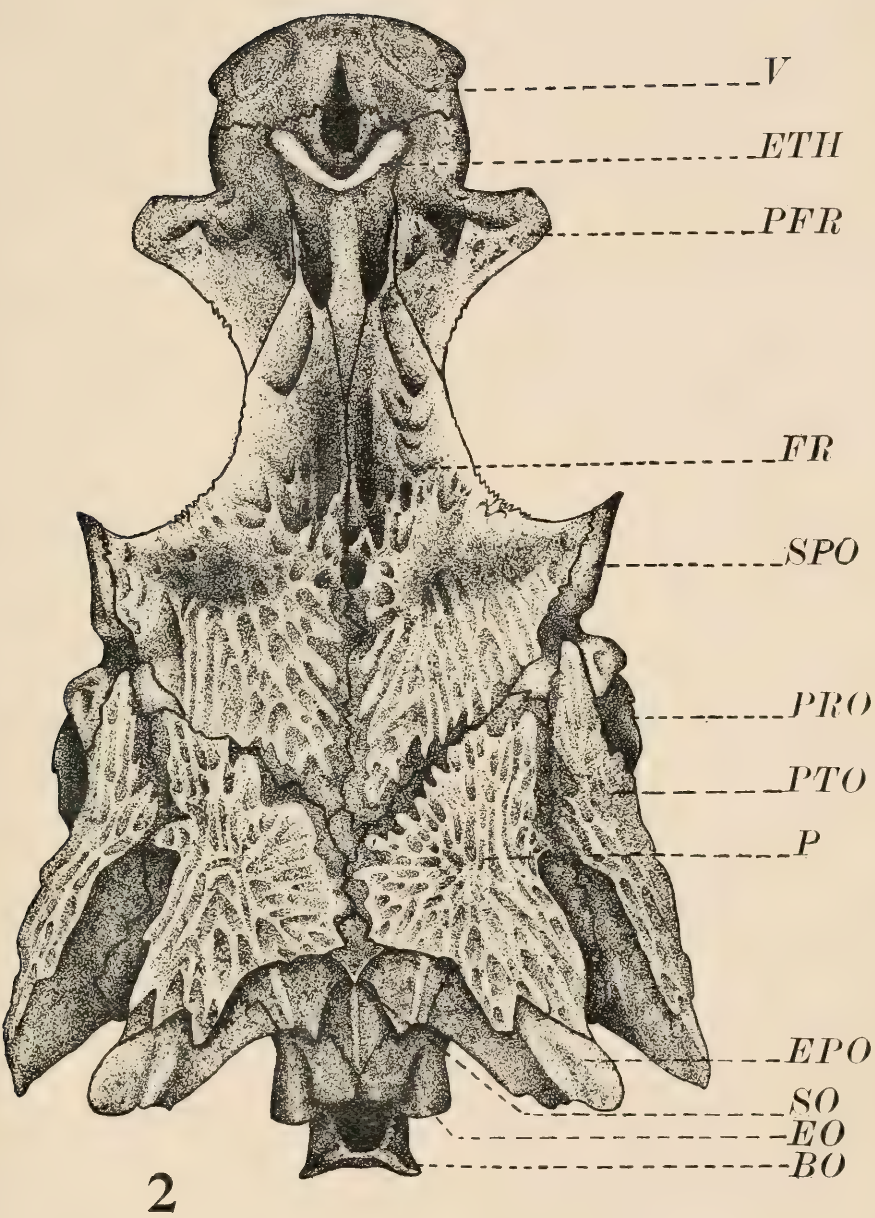
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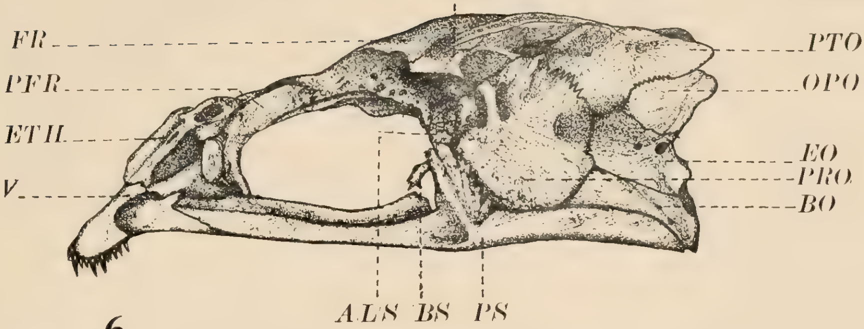
PLATE II

PLATE III

EXPLANATION OF PLATE

Fig. 3. Prepoercular of *Scorpianichthys marmoratus.* Two-thirds natural size.
Fig. 4. Preopercular of *Ophidon elongatus.* Two-thirdds natural size.
Fig. 5. Lateral view of skull of *Scorpionichthys marmoratus.* Two-thirds natural size.
Fig. 6. Lattral view of skull of *Ophidon elongatus.* Two-thirds natural size.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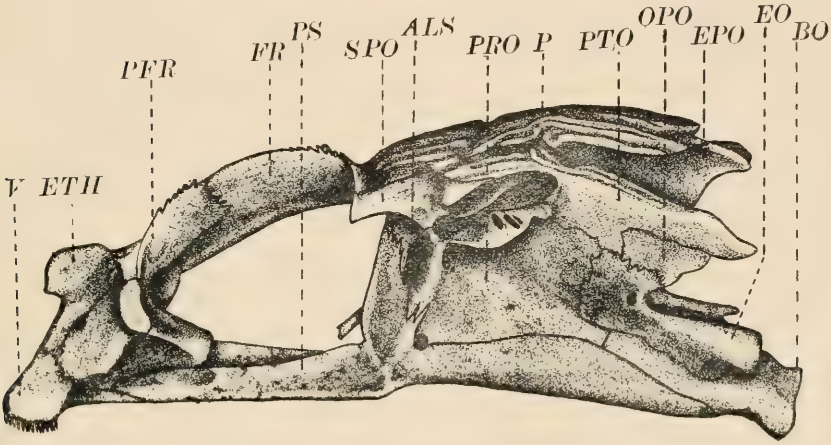
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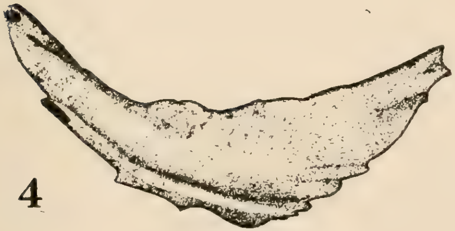

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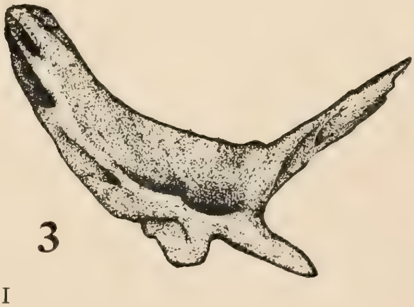

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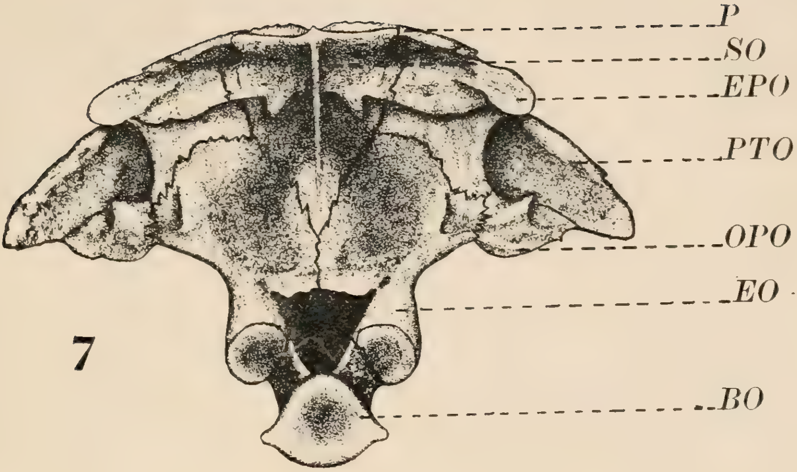
PLATE III

PLATE IV

EXPLANATION OF PLATE

Fig. 7. Posterior view of skull of *Scorpionichthys marmoratus.* Three-fourths natural size.
Fig. 8. Posterior view of skull of *Ophidon elongatus.* Three-fourths natural size.
Fig. 9. Premaxillary of *Ophidon elongatus.* Three-fourths natural size.
Fig. 10. Premaxillary of *Scorpionichthys marmoratus.* Three-fourths natural size.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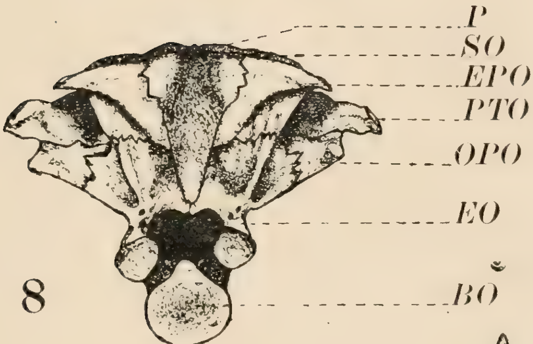
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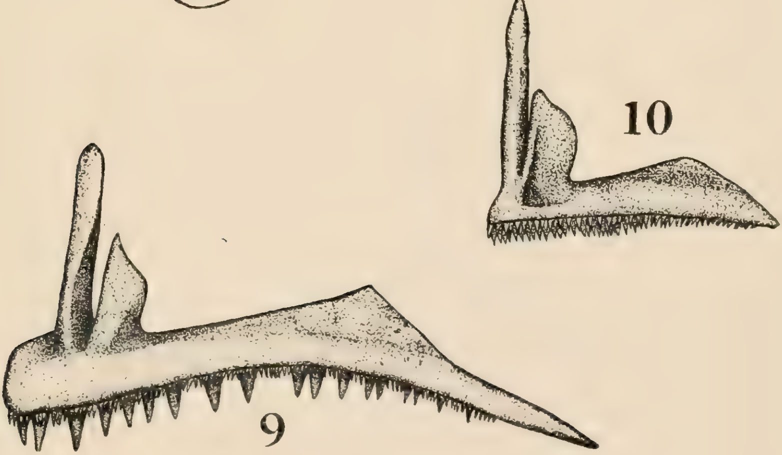

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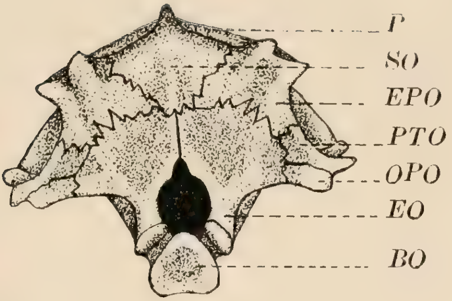
PLATE IV

PLATE V

EXPLANATION OF PLATE

HEXAGRAMMOS DECAGRAMMUS

Fig. 11. Posterior view of skull. One and one-half times natural size.
Fig. 12. Lateral view of skull. One and one-half times natural size.
Fig. 13. Dorsal view of skull. One and one-half times natural size.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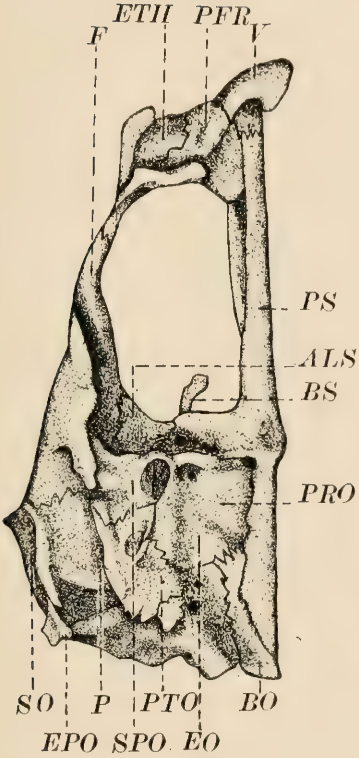
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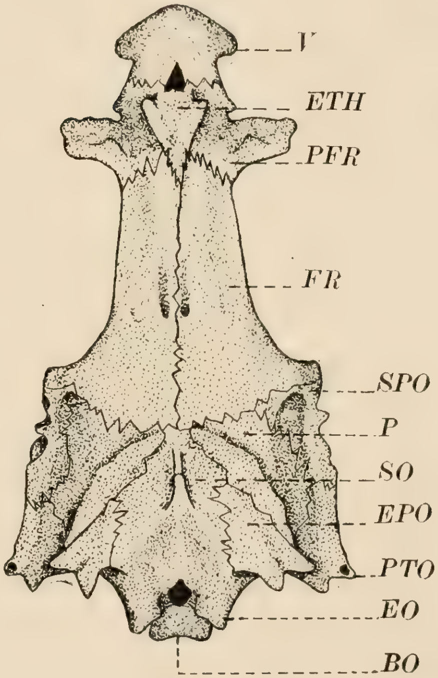
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PLATE V

ILLINOIS BIOLOGICAL MONOGRAPHS

Vol. II January, 1916 No. 3

EDITORIAL COMMITTEE

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PUBLISHED UNDER THE
AUSPICES OF THE GRADUATE SCHOOL BY
THE UNIVERSITY OF ILLINOIS

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Distributed June 29, 1916

STUDIES ON GREGARINES

Including Descriptions of Twenty-one New Species
and a Synopsis of the Eugregarine Records
from the Myriapoda, Coleoptera and
Orthoptera of the World

WITH FIFTEEN PLATES

BY

MINNIE ELIZABETH WATSON

Contributions from the
Zoological Laboratory of the University of Illinois under the direction of
Henry B. Ward No. 65

THESIS

Submitted in Partial Fulfillment of the Requirements for the
Degree of Doctor of Philosophy in Zoology
in the Graduate School of the
University of Illinois
1915

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INTRODUCTION

The following pages contain results from the study of a number of species of gregarines found as parasites in various Orthoptera, Coleoptera, and Myriapoda during the past three years. The work was done chiefly in the zoological research laboratory of the University of Illinois, under the supervision of Professor Henry B. Ward. I am deeply indebted to Professor Ward for his direction and helpful suggestions throughout. Four of the species described were found and studied at the Biological Laboratory of the Brooklyn Institute, Cold Spring Harbor, Long Island, N. Y., and I wish to express my gratitude to Dr. C. B. Davenport for the opportunity of carrying on investigations at the Station. I wish also to thank Professor F. D. Barker, Professor H. B. Baker, and Mr. Elmer Shafer for kindly sending me material from which parasites were obtained.

The gregarines were studied in order to procure data in addition to that already known concerning (1) their biology including the habitat, relation to the host, seasonal distribution, and character of movement, (2) their modes of reproduction, and (3) their systematic position; twenty-two species are described for the first time while additional data is given for many more species. One result of the work was the compilation of a synopsis wherein are recorded in concise form the known facts concerning all the polycystid gregarines which literature records from the Orthoptera, Coleoptera, and Myriapoda of the world. A list was made of all the polcystid gregarines known, with their hosts, in order that species may not be recorded as new which have hitherto been discovered and that new species may not be given names which have already been used.

TECHNIC

The following method was used in studying the live parasites: The anterior and posterior extremities of the host are clipped off as close to the ends of the animal as possible and the alimentary tract is drawn out intact. It is then slit lengthwise with fine scissors, placed flat on a slide, and the masses of food and the parasites then teased out carefully to form a layer as thin and as nearly transparent as possible.

Distilled water and normal salt solution were found to be the best media in which to observe the live gregarines. Plasmolysis is slower with the former, while the parasites remain motile longer in the latter. A minimum amount of water or salt solution is used and a cover slip placed over the material to prevent rapid evaporation. The animals are now in an unnatural medium and will disintegrate rather rapidly, so sketches of those which are to be measured must be made with the camera lucida as soon as possible, using a minimum amount of light and a power of the miscroscope of about 100 diameters. When the parasites are nearly transparent, as are those of the species inhabiting the Coccinellidæ, e. g., a drop of iodine-iodide solution will turn them brown and thus render them visible; a weak saffranin solution serves to bring out *in vivo* the nucleus and sometimes the longitudinal striations.

Although the parasites are best studied alive, some stained preparations are valuable. In order to preserve parasites in toto for future study, the intestine of the host is slit lengthwise and teased apart gently to loosen the food masses and the parasites. It is then dropped into the fixing solution and agitated gently when the free parasites will drop to the bottom of the dish. The best fixing agent is corrosive-sublimate solution to which has been added a trace of acetic acid; the precipitate is first washed with 50% alcohol and iodine, then with 70% and iodine, and the parasites preserved in 70% alcohol until needed. Picro-formol after Bouin was used in some instances with good results.

For staining in toto, two methods are advisable. The slide may be smeared with a very small amount of egg albumen, the animals dropped upon it from a capillary pipette and the preparation placed horizontally in a dish of 35% alcohol for about two minutes to coagulate the albumen. It may then be carried very gradually down the alcohols to a water solution of Ehrlich's hematoxylin or to a rather weak alcoholic solution of borax-carmine and in the latter instance counter-stained with picric acid. The alcohols and stains should be placed in flat dishes so that the slide may be kept horizontal and gradualy immersed and withdrawn from each solution to insure against loss of the parasites. Many grades of alcohol should be used and the parasites kept in each alcohol about fifteen minutes.

If the material is abundant, the parasites may be stained *en masse* in a small dish, since they settle to the bottom, but there is always considerable loss in the transfer of liquids.

When material is very scarce and all of the parasites must be kept, it is best to preserve simply in glycerine. Parasites from one host intestine can be placed on several slides. A weak mixture is made of glycerine and water and a very little of this used, the parasites being under observation under the microscope the while, for it is very easy to add too much glycerine and in an instant destroy all the material. The water is very gradually withdrawn by adding a little glycerine for several successive days. A little safranin, erythrosin, or other stain may be added to the mixture and will be taken up by the parasites. The colored solution can be removed from the slide as the glycerine applications are made stronger.

The study of totos should be supplemented as far as possible with sections. In the instance of the small species not visible to the eye, sections afford the only means of studying the exact location in the host. The whole alimentary tract is fixed and sectioned intact. Sections must be cut very thin, about two micra for the smaller species. Ehrlich's hematoxylin has been found the most satisfactory stain; it may be used alone or counter-stained with either erythrosin or eosin. Sections reveal the relation of the young parasite to the host cell, whether attached by an epimerite or intercellular, the position of the free sporonts in relation to the cell walls, and various points in structure of the sporonts. By means of sections the position of the sporont can be determined, whether inside or outside of the alimentary tract or its appendages. If the parasite is able to bore through the walls of the intestine into the coelom, the actual burrowing process is often depicted in a series of sections; whether the pyloric cæeca are a seat of infection is also revealed in this manner.

PREVIOUS WORK ON GREGARINES

In 1903 Minchin adequately summarized the history of gregarines from the time of Redi, who in 1708 recorded the discovery of what was possibly a gregarine, through Dufour, who gave in 1828 the first authentic account of these forms and named the genus which he found *Gregarina,* up to the beginning of the present century.

Other historians of the gregarines have been Lankester, in 1863, Bütschli, in 1882, and Léger, in 1892.

Like all groups of which little is known, much of the literature of the gregarines is purely systematic in character. Since Minchin's synopsis was written in 1903, as well as previously, work on the gregarines has been chiefly systematic. Many new species, a dozen new genera, and a very few new families have been named in the last decade. The suborder Schizogregarinæ (Minchin) has received considerable attention from such workers as Léger and Duboscq, Fantham, Siedlecki, Dogeil, and Brasil, and they have described many new species from Crustacea, tracheate Arthropoda and Holothuroidea. A few new species have been described among the Eugregarinæ by European and South American workers, and in the United States Crawley, Hall, and Ellis have contributed considerable data concerning new species, all those in the last named country being parasitic in tracheate Arthropoda.

Lühe (1903) and Sokolow (1911 and 1912) have given particular attention to the physiology, morphology and reproduction of gregarines in general.

A LIST OF TERMS USED IN DESCRIBING GREGARINES

Association: The group formed by the attachment of two or more sporonts.
Biassociative: The adjective referring to an association of two sporonts attached by unlike ends.
Cephaline gregarine: One which possesses an epimerite at some stage in its life history.
Cephalont: A term applied to the young gregarine with an epimerite.
Cyst: The structureless covering secreted by the associated sporonts at the beginning of reproduction.
Deutomerite: The portion of a sporont which is preceded by the septum.
Ectoplasm: The outer zone of the body comprising the epicyte, sarcocyte and myocyte.
Endoplasm: The granular protoplasm found within the ectoplasm.
Epicyte: The thin, fragile, external layer of the ectoplasm.
Epimerite: The temporary or rarely permanent structure at the anterior end of the protomerite by which the young parasite is attached to the host cell. It is derived from the epicyte.
Isogametes: Gametes which are morphologically identical. Present in most gregarines.
Karyosome: A chromatic mass surrounded by plastin and contained within the nucleus. The young individuals possess a single karyosome which often buds off others as the animals increase in size.
Longitudinal striations: The very delicate ridges which are on the outside of the epicyte.
Myocyte: An hypothetical ectoplasmic layer consisting of the myonemes.
Myonemes: The network of contracile fibrillæ embedded in the periphery of the endocyte and running around the animal crosswise. They produce movement.
Octozoic Spore: A spore containing eight sporozoites.
Polycystid: A term applied to gregarines possessing a septum which divides the endocyte into regions. Infrequently more than one septum is present.
Primite: The first individual in an association of two or more sporonts.
Protomerite: The portion of a sporont which precedes the septum.
Pseudocyst: The residual protoplasm which after the spores are separated acquires a membranous wall, swells until the true cyst-wall bursts and allows the extrusion of the ripe spores.

Sarocyte: A middle layer of the ectoplasm.

Satellite: Any sporont in an association which is attached behind the primite. Generally there is but one, but sometimes several are attached in a cluster to the posterior end of the primite or, more generally, arranged linearly one behind the other.

Septum: The thin layer of sarocyte which separates the two portions of the sporont, the protomerite and the deutomerite.

Spore: The body into which the zygote develops after the acquisition of a resistant outer coating.

Spore duct: A tubular outgrowth from the cyst through which the spores are exuded when ripe.

Sporocyst: The covering or coverings of the spore.

Sporont: An adult gregarine living free in a cavity and deprived of its epimerite.

Sporozoite: One of the eight, more or less, small falciform bodies which are released when the spore walls are absorbed.

Trophozoite: The young parasite which is either entirely intercellular or attached to an epithelial cell of the host by an epimerite. Synonymous with cephalont.

Zygote: The body formed from the union of two gametes.

PART I BIOLOGY

THE HOSTS INFECTED

Gregarines infect only invertebrates and they have been reported from the following phyla: Coelenterata, Echinodermata, Platyhelminthes, Coelhelminthes (Archianellidæ, Gephyrea, Hirudinea, Annelida Polychæta and Oligochæta), Arthropoda, (Crustacea, Onycophora, Myriapoda, Hexapoda, and Arachnida), Mollusca and Chordata (Enteropneusta and Tunicata). Thus far the only groups below the vertebrates from which gregarines have not been reported are the phyla Rotifera, Porifera, and Protozoa, and the sub-phylum Leptocardii.

Partial List of Animals Examined for Gregarines

	Number examined	Number parasitized
Myriapoda		
Scutigera sp.	10	0
Scolopendra sp.	5	0
Scolopocryptops sexspinosus	10	2
Lithobius sp.	15	6
Geophilus sp.	15	0
Euryurus erythropygus	2	2
Callipus lactarius	24	20
Parajulus impressus	30	25
Polydesmus virginiensis	6	0
Spiribolus marginatus	6	0
Julus sp.	10	0
Hemiptera		
Reduvius sp.	10	0
Many unidentified		0
Diptera		
Musca domestica	10	0
Unidentified larvae	50	0
Neuroptera		
Damsel fly larvae	15	0
Dragon fly larvae	30	5
Lepidoptera		
Many unidentified larvae		0

Partial List of Animals Examined for Gregarines

	Number examined	Number parasitized
Mollusca		
Venus mercenaria	10	0
Mactra solidissima	5	0
Mya arenaria	10	0
Mytilus edulis	5	0
Modiola sp.	5	0
Pecten irradiens	10	0
Ostrea virginica	15	0
Crustacea		
Porcellio sp.	8	0
Oniscus asellus	30	0
Talorchestia longicornis	500	200
Orchestia agilis	50	2
Orchestia palustris	10	0
Balanus eburneus	5	0
Balanus balanoides	50	0
Panopeus sayii	10	0
Eupagurus bernhardi	25	0
Uca pugilator	50	40
Uca pugnax	20	15
Cancer irroratus	4	0
Platyonichus sp.	4	0
Libinia dubia *Libinia emarginata*	50	40
Annelida		
Nereis sp.	5	5
Amphitrite sp.	6	2
Enchytraeus abbidis	12	6
Heliodrilus caliginosus	6	6
Allobophora foetida	4	4
Lumbricus terrestris	3	3
Cerebratulus lacteus	4	0
Coleoptera		
Carabidae	25	3
Galuita janus	30	0
Helanotus fissilis	7	0
Hydrophilus triangulis	3	0
Pterostichus stygicus	10	4
Dytiscidae	25	0
Gyrinidae	15	0
Dinetus assimilis	5	0
Agabus semivittatus	4	0
Tenebrionidae	15	7

Partial List of Animals Examined for Gregarines

	Number examined	Number parasitized
Passalus cornutus	24	0
Elateridae	7	4
Coccinellidae	30	3
Coccinella sp.	10	3
Coccinella novemnotata	5	3
Amara angustata	5	5
Coptotomus interrogatus	7	5
Orthoptera		
Ceuthophilus stygius	15	8
Forficula auricularia	15	0
Ichnoptera pennsylvanica	10	4
Gryllus abbreviatus	200	150
Gryllus pennsylvanica	100	80
Melanoplus femur-rubrum	300	200
Melanoplus differentialis	50	10
Melanoplus acridiorum	5	5
Melanoplus bivitattus	10	6
Schistocerca americana	2	1
Dissosteira carolina	10	5
Encoptolophus sordidis	25	15
Arphia sulphurea	5	5
Hesperotettix pratensis	10	8

This list is incomplete for many animals were examined and not identified when parasites were not found. The numbers given above are approximate.

LOCALITIES REPRESENTED

The hosts from which the parasites described in this paper were taken occurred chiefly in and around Urbana, Illinois. Some were taken in New Jersey, many on Long Island, and the marine material from Long Island Sound; material was received from Haverford, Pa., Colorado Springs, Colo., and Lincoln, Neb., which afforded new data on the distribution of several species.

SEAT OF INFECTION

The most frequently observed location for the sporonts is the mid intestine of the host. The parasites are not found in the esophagus, crop, or rectum except when the infection is very heavy. The pyloric caeca are sometimes infected and parasites attached to the intestinal walls have been recovered in great numbers from the coelom of a very few insects. Cysts are often recovered from the mid intestine but usually from the rectum. They can be easily procured from the moistened feces of those species in which they are large enough and opaque enough to be distinguished with the eye. I have been able to procure them in this manner from the Acrididae.

Cross-sections of the host intestine reveal the fact that the sporonts lie close to the epithelial walls and are not scattered through the food masses. In the Myriapoda, they lie deeply seated between the lobes of the intestine where they are not easily dislodgd. Thus the parasites are in position to absorb the richly laden digestive juices just before the latter reach the villi, and are not in danger of being swept along to the exterior by the peristaltic movements in the intestine.

In the Acrididae sporonts and trophozoites are found in the pyloric caeca as well as in the intestine. In the Myriapoda the sporonts are able to bore through the walls of the intestine and have been found, though rarely, in the coelom. One species of the genus *Steinina* was found in a beetle in masses on the outside of the intestinal walls, projecting into the coelom.

At least one family, the Stenophoridae, is intercellular in development and the trophozoites are embedded in the intestinal walls of the host; in the Gregarinidae, however, one end only of the trophozoite is projected into the epithelial cell of the host.

SEASONAL VARIATION WITHIN THE HOST

Investigation of the seasonal variation of gregarines was confined to the Acrididae and the Gryllidae, of the order Orthoptera. It extended over a period of two years. Locusts were collected around Urbana from early spring until about June 20, and were then very generally parasitized but the number of parasites per host was small, averaging from one to ten. The nymphs of the Acrididae which hatch in the early spring were not infected in April but showed a slight infection when examined in June.

In the fall, observations were again made at Urbana and disclosed a considerable increase in parasitism. Nearly every locust examined was heavily infected, fifty parasites being an approximate minimum.

The same increase in the fall was found to be true of the gregarines in crickets. About fifty adults were examined at Urbana in June and it was found that only five or six were infected, and these with very few parasites. In the fall of the same year practically every cricket examined revealed a heavy infection.

Crickets were examined frequently throughout July and August of two successive summers at the Biological Laboratory, Cold Spring Harbor, L. I. The parasitism here steadily increased from sparse to heavy inside of two months. Conditions there were particularly favorable to the rapid increase. The crickets were collected on the Sand Spit, a long narrow peninsula separating the inner and outer harbors, and were taken from under the flotsam and jetsam which is brought to the inside of the spit by the incoming tide. There are no waves on this inner beach to change appreciably the upper limits of the tidal zone and the crickets were undisturbed. The cricket population is large and flourishing because of the influx of organic debris. Thus the insects are confined to a restricted habitat and as cysts are produced and the spores scattered, the animals are reinfected over and over again.

A number of crickets were taken in August from debris along the shores of Northport Harbor and Huntington Beach, Long Island, and all were uninfected. Both these localities are part of the exposed shore of Long Island Sound. A number were taken inland at Arlington, New Jersey, and were also uninfected. Practically every cricket examined in the late summer at Cold Spring Harbor and at Oyster Bay (four miles distant) was infected. The only explanation which can be offered by the writer for these phenomena is that the spores, having once become established in restricted area, have not yet found the means of becoming scattered broadcast but reproduce themselves in enormous numbers in restricted localities.

RELATION OF PARASITE TO HOST TISSUE

The effect of the parasite on the host is a subject still under discussion. Very little actual investigation has been carried on in this field but it is one which offers many interesting problems in biological chemistry.

In the growing stages, the Eugregarine is either completely intercellular without an epimerite, or possesses an epimerite by which it is attached to the epitelial cells of the host intestine, this factor depending on the family to which it belongs. All the Acephalinae (including *Monocystis*) and some of the Cephalinae (e. g. the Stenophoridae and the genus *Frenzelina* of the Gregarinidae) are intercellular; most of the cephaline Eugregarinae are not, however, intercellular but possess epimerites which alone penetrate the host cells.

When the parasite is completely intercellular, the sporozoite penetrates the free end of the cell, works its way inward by ameboid movement (Léger and Duboscq, 1909) and comes to rest in the vicinity of the nucleus. The parasite at once begins to affect the nucleus, causing the breaking up and rearrangement of the chromatin into small more or less spherical bodies which react differently to the stain than do the normal nuclei. The cytoplasm also is affected chemically for it stains less deeply than the normal cell cytoplasm.

Siedlecki (1901) thinks these changes are due to a substance secreted by the parasite. Using *Monocystis ascidiae* for material, he found that the parasitized cell is at first greatly enlarged. The parasite within this enlarged cell then increases enormously in size so that the host cell and its contents may be ten or more times the size of the normal epithelial cell; the parasite finally breaks out, for its rate of growth exceeds that of the epithelial cell, whereupon the latter shrinks and finally disappears, the adjoining cells gradually filling in the space left. The author says the chemical substance secreted by the parasite at first stimulates growth in the epithelial cell and later retards it, killing the cell, the parasite escaping after dissolution has set in. The normal excretion must be emptied into the cytoplasm of the epithelial cell of the host and may provoke changes therein but whether or not the cell is killed by the entrance of this foreign substance is a question. There is no other source of food for the parasite than by absorption from the cell which surrounds it, and it appears to the writer that the shrinking of the cell is due at least in part to the gradual withdrawal of its liquid content and the absorption of the latter by the contiguous parasite. How else the intercellular parasite grows is not easily explained. If the host cell is killed by toxins which are the excretory products of the parasite, the dead protoplasm is gradually used up as food for the growing organism. An animal is generally poisoned by its own excretory products; the gregarine would seem to be an exception unless it is possible that the host cell remains alive and throws off the excretions of the parasite along with its own.

Those parasites which are not intercellular possess epimerites by which they are attached to the free end of the epithelium of the host, the rest of the parasite lying in the lumen of the intestine.

Five questions may be asked in this connection: (1) Does the *epimerite* absorb food from the parasitized epithelial cell? (2) Does the epimerite absorb from the latter *all* the food that the gregarine receives? (3) Does the *epicyte* of the gregarine body absorb all the food from the lumen of the intestine, and the epimerite act only as a holdfast organ? (4) Is a toxic substance given out through the wall of the parasite into the lumen of the intestine which is absorbed by the parts of the epithelial cells nearest the surface?

Laveran and Mesnil (1900) state that in *Pyxinia frenzeli* the cell to which the parasite is attached at first greatly hypertrophies then atrophies and finally disappears completely about the time the cephalont is ready to discard the epimerite and live free in the intestine. The hypertrophy, they say, is due to an increase in the liquid content of the cell only, with a decrease in the density of its cytoplasm and nucleus. They do not attempt to give an explanation for the cause of the phenomenon.

Léger and Duboscq (1902) think this hypertrophy is only apparent and not real, for the penetration of the sporozoite into the cell irritates it so that the cell contracts in length at the same time increasing in width, the latter phenomenon giving rise to the idea that there is hyertrophy. They think the parasite absorbs the cell content through the epimerite alone, and that constant and steady increase in the withdrawal of the cell sap accounts for the apparent atrophy.

Pyxinia mobuzzi (Léger and Duboscq, 1902) possesses a long tongue-like epimerite (Fig. 98) which extends longitudinally through the penetrated cell as far as the mesothelial layer of the intestine. The penetrated cell seems to be uninjured by this epimerite and the authors think the animal absorbs blood from the capillaries in the mesothelium by means of the epimerite.

The Dactylophoridae, e. g., *Nina gracilis* Grebnecki (Fig. 30), have epimerites with many long radices, which Léger and Duboscq (1902: 458) state penetrate at many places several adjoining cells and probably function as an apparatus for nutrition. Many genera, *Beloides, Pyxinia,* etc., have a long central style in the epimerite which punctures the cytoplasmic vacuoles and absorbs the cell sap directly.

Siedlecki (1901:98) says the long filaments from the epimerite of *Nina gracilis* penetrate into the epithelial layers between the cells and do not puncture the cells themselves, as Léger and Duboscq think.

Minchin (1912) says that the cytoplasm of the cell is absorbed by the parasite, which I infer to mean used as food, and that ''when the cytozoic phase is past and the host cell exhausted, the parasite drops off, shedding its epimerite.''

The present writer agrees with Léger and Duboscq and with Minchin that *there is absorption through the epimerite.* When a free cephalont is stained, its epimerite is seen to contain considerable endoplasm and not to be merely an ectoplasmic structure filled with sap. Moreover, stained sections of parasitized epithelium reveal the presence of attached cephalonts which are transparent or nearly so and which do not absorb the stain. Living material often contains large numbers of free cephalonts which contain but very little protoplasm or none whatever. These facts lead to the theory that the epicyte is not yet in physiological condition to absorb fluids from the intestine but that all such absorption takes place through the epimerite. Whether or not the epimerite possesses an epicyte of different structural character from that of the rest of the body is not known. It does, however, possess a very delicate, fragile, highly permeable layer susceptible to slight changes in osmotic pressure. The suggestion may be made that because the chemical constituency of the fluids in the lumen of the intestine and in the epithelial cells is obviously dissimilar, the parasite may or may not be able to absorb either of these fluids through the epicyte; and if they are absorbed may not be nourished by one of these ingested fluids. The fact that the epimerite often contains protoplasm while the rest of the cephalont is still transparent or nearly so and that the cephalont remains nearly transparent as long as the epimerite persists, leads to the theory that whereas at first all the absorption takes place through the epimerite, as the cephalont develops there occurs a gradual change in food from the predigested cell sap to the juices free in the intestinal tract as well as a transfer in its mode of absorbing these substances from the epimerite to the general epicyte of the body. The general epicyte of the body may be physiologically different when the cephalont is very young from that when it is nearly ready to discard the epimerite.

The third question: *Does the epicyte of the gregarine body absorb all the food from the lumen of the intestine and the epimerite only act as a holdfast?* has been answered above in the negative. There may come a time when maturity approaches and the epimerite is at the point of being discarded when the question may be answered in the affirmative; during the greater part of the cephalont life, however, the epicyte is probably ineffective in absorbing nourishment.

Is a toxic substance given out into the parasitized cell through the epimerite of the parasite? Siedlecki (1901:100) says the presence of the parasite within the cell *(Monocystis ascidiae)* incites hypertrophy, then atrophy, and that these phenomena are due to the chemical action of the parasite. In another species, however, *Nina gracilis,* which possesses numerous long protoplasmic filaments which penetrate deeply into the epithelium of the intestine, the author says of these threads

> "Tous ces changements provoques dans l'epithelium sont de nature purement méchanique."

He has observed changes in form and displacement of the cells but regards these as unallied to the hypertrophy and atrophy which is induced by chemical excitation.

Siedlecki finds in one instance a chemical effect excited by the presence of the parasite in or attached to a cell; in another species purely a mechanical affect; while Léger and Duboscq, as mentioned, believe the apparent hypertrophy due to mechanical irritation of the parasite upon the cell rather than to any toxin secreted by the parasite. Yet illustrations given by Léger and Duboscq to prove a mechanical effect indicate a different staining reaction in the case of many of the parasitized cells and a rearrangement of the chromatin in the nucleus unlike that in normal cells.

The last question is stated as follows: *Is a toxic substance given out through the epicyte of the parasite into the lumen which is absorbed by the parts of the epithelium nearest the surface?* It is often the case that the free end of the cell is shrivelled first. This end is nearest the hypothetical center of influence of the toxin which would be given out through the body of the parasite exposed in the lumen. It is also the end which is penetrated by the epimerite and the part naturally used as food first. The fact that the whole cell often reacts differently to the stain and not the outer end only, and that the deep seated nucleus is affected by the very small parasite indicates the untenability of this theory as a cause of cellular reaction to the parasite.

A theory for the shrivelling of the parasitized cell may be derived from the facts of liquid pressure. The cell wall is normally under some pressure from within, due to turgor. When the cell is punctured by the sporozoite, some of the cell sap might ooze out. Most of the liquid content of the cell is, however, contained in vacuoles and not liable to be affected by the puncture. The viscid cytoplasm of the cell would probably be unable to find exit through the small opening. The puncture is as small as is the penetrating sporozoite and closed by the same. The parasite grows rapidly, enlarging the opening only as fast as the parasite grows. I have in no instance seen a section wherein the cell wall was torn by the growing animal, and in every instance the two fitted together tightly so as to form seemingly one layer at the neck of the epimerite. Thus the theory of loss of cell content by the oozing out through the puncture made is untenable.

MOVEMENT IN GREGARINES

Movement in Gregarines has probably been observed as long as the animals themselves. Dufour (1837:11) said

> "Leurs movements sont fort obscur et leur locomobilite est d'une lenteur extreme; cependant je les ai constates."

Siebold (1837:408) doubted that Gregarines were animals for he saw no movements. Kölliker (1848:32-3) described movement of the gliding type as

> "Eine langsam vorwärtschreitende Bewegung ohne sichtbare Contractionen der Leibeshülle."

He also noted the bending movement and describes it as follows:

> "Bewegung nach dieser oder jener Richtung durch mehr oder minder energische, auf verschiedene Weisen sich combinirende Zusammenschnürungen der Leibeshülle."

Kölliker did not attempt to explain the cause of these movements but he answered the question raised by Siebold ''Are the Gregarines animals?'' by describing the violent contractions seen in many of his new species, movements which only animals possess.

Leidy (1849:232) ''detected movements of an animal character,'' and discovered the longitudinal striations of the epicyte which he thought were muscular in function.

Van Beneden (1872) discovered the network of transverse fibrillae which Schneider (1875:505) called the myocyte. Contractility of the elements in this myocyte has since then been assigned as the basis for the bending movements of Gregarines.

The first explanation for the gliding movement was offered by Schewiakoff (1894) who supposed a gelatinous secretion from the posterior end of the body formed a stalk and that as the animal secreted new additions to this stalk it pushed itself forward by the same amount.

Porter (1897) probably without knowledge of Schewiakoff's theory proposed the following hypothesis:

> "It [locomotion] is a 'very slow movement of translation in a straight line' without any apparent contraction of the walls of the body. It is probably caused by a very slight undulatory motion of the under surface of the animal."

Crawley (1902:420; 1903:57), unaware of Porter's hypothesis, came to the same conclusion that an undulatory movement on the under side of the body is the basis for locomotion; and he disagreed with Schewiakoff's explanation.

My observations on movement in Gregarines have been chiefly confined to the species *Leidyana erratica* of the family Gregarinidae because of its activity and the readiness with which material is obtained.

In the normal intestinal juices of the host when the intestine is first opened, practically none of the animals are in motion; they lie rather in inert masses from which the name Gregarine is derived. Since the juices rapidly evaporate and cannot be secured from other animals in sufficient abundance to observe normal movement over a considerable portion of time, artificial media must be used, the most common being distilled water. This causes the animals to disintegrate after periods varying from fifteen minutes to three or four hours, depending on the age of the parasites and their consequent ability to adapt themselves to a change in external pressure. The young, fragile animals disintegrate rapidly; the oldest often resist the change in external pressure for several hours. When an epimerite is present on a free individual, it is quickly ruptured in water.

Egg albumen is not a satisfactory medium in which to observe motion, for the parasite has great difficulty in ploughing its way through the thick substance. Rupture of the walls is prevented by its use because of a similarity in density between the animal protoplasm and this medium.

Various acids in 0.5% solution were used and their effects on motion noted, among them being hydrochloric, nitric, acetic, sulphuric, and tannic. All of them killed the animals very quickly and caused the protoplasm to collect in masses; the epicyte was also often ruptured. Chloroform and sulphuric ether in 0.5% solutions produced no apparent structural changes but the parasites were quickly anesthetized.

Normal salt solution acts as a stimulant to motion and in it the parasites remain alive and active longer than in water. It is therefore the best medium in which to observe motion. Sea water has practically the same effect as normal saline.

Movement of location consists of a uniform gliding progression with no apparent localized motion of the body. It is best seen in animals from a freshly opened host intestine mounted on a slide and supplied with an abundance of light. The parasites are negatively heliotropic and consequently attempt to avoid the light rays by moving rapidly from the tissues toward the periphery of the cover slip and down the sides until they encounter masses of debris under which they try to hide.

The rate of progression has been measured in several instances. It averaged 0.8 micron per second in *Leidyana erratica.* The same individual is able to increase or decrease its rate of motion through a considerable range. A sample set of successive rates, measured at intervals of 15 seconds, reads as follows: 0.7, 1.8, 4, 5.6, 2.8, 1.5, 0.8, and 0.0 per second. An accompanying diagram (Fig. 233) illustrates progression combined with bending movement and the distances covered in successive time intervals. In the Stenophoridae motion of progression is slower, an average being .007 per second for two species, one of which was five times the length of the other and of correspondingly greater volume.

Just how the progressive movement is effected is a matter much discussed. Schewiakoff (1894) makes the statement that it is caused by the secretion of a hollow gelatinous ''stalk'' formed of contiguous threads at the posterior end of the body which pushes the animal forward. He says that the gregarine is able to move only until its store of secretion is exhausted and cannot go on until it has accumulated the materials from which to secrete a new addition to the ''stalk''.

Upon cutting off most of the light from the field, there can be seen many fine threads leading from the posterior end of the gregarine back to a mass of debris from which it is apparently trying to extricate itself. A slight motion of the microscope or of the table beneath will cause the threads to tremble; but even a slight movement of the cover slip does not rupture them. I have often observed the animal swinging about in an arc at the end of this fastened thread or strand of threads without breaking it. This was noted in twenty-five instances in a single field and was repeated by the parasites until their walls were ruptured and the protoplasm oozed out.

After a mount has been made for some time and the gregarines have become scattered about in the debris, many animals can often be seen headed away from inert masses, moving a short distance forward and then being jerked quickly back as if by some invisible spring. When an animal is able to free itself, the relase is sudden and the distance traversed often as great as the time it takes is short. The release may be compared to the cutting of a tense cord. Generally, however, the parasite is not able to effect its release and keeps on trying until the walls are ruptured or death ensues from some other cause.

I have never observed backward gliding movement. The only backward motion seen was the sudden jerking mentioned above. This phenomenon may possibly be accounted for in the following manner: The animal exerts considerable effort to move forward against the backward pull of the threads and debris behind it. Its body becomes stretched out long and narrow by the contraction of the myonemes. These myoneme fibrillae suddenly relax and the body becomes shorter and normal in shape. As the tension on the caudal threads is thus released, the body is drawn backward with a sudden jerk. The motion is thus passive, a simple reaction and not actively incited motion in a backward direction.

It is not to be denied, then, that there are formed gelatinous threads which seem to fuse and form a thick thread or strand from the posterior end of the body, but these threads are obviously an hindrance rather than an incentive to progression. My theory concerning the reason for the presence of such a group of threads will be discussed later.

Granted here that such a group is present, it obviously comes from the animal itself and is carried to the posterior end of the body by the longitudinal ridges which gregarines possess (see Fig. 243 for illustration of these longitudinal ridges). The animal in a mass of debris tries to liberate itself. In this motion there is secreted a lubricating substance which in a medium other than the normal digestive juices adheres to the debris. In endeavoring to get free, a great deal of energy is expended and considerable lubrication secreted; and thus the thread is formed from which the animal is unable to extricate itself. Each added trial only causes more secretion to be poured out and makes the snare the more secure. The body becomes drawn out long and slender indicating the strain which the animal undergoes (Fig. 236).

I suggest the hypothesis that normally there is a secretion which reaches the posterior end. When a parasite is moving through a medium in which there is fine scattered debris, it picks up much of it. After a considerable accumulation has taken place, one of two things may happen: The end masses may drop off by their own weight, the force exerted by the strand of threads being less than that exerted either by the progressing animal or by the dead weight behind. If the strand withstands the stress exerted by the moving animal but the dead weight exerts greater force than the combination of the other two, the strand and the animal, the parasite is caught and eventually dies.

The presence of the caudal threads can often be demonstrated with carmine. In a freshly made mount the carmine does not seem to adhere and I have never been able to demonstrate the presence of threads in a freshly opened intestine. The medium must then be other than the normal digestive juices. It thus seems possible that no strands are present in the normal condition but that they harden only after being for some time in an unnatural medium. Instead of hardening and condensing in the host, the constituents of the secretion are probably dissolved in the digestive juices as fast as formed.

As the reason for the presence of the semi-gelatinous secretion from the body, I accept the view of Porter which states that movement is probably caused by a very slight undulatory motion of the under surface of the animal. Just as *Limax* moves forward by a slight ventral, and dorsally imperceptible, muscular movement in a vertical direction on an underlying surface the friction of which is caused by the secretion of a sticky mucus, the gregarine moves forward by imperceptible vertical movements in the myonemes on that side of the body which happens to be ventral at the time, friction being produced with the under surface by the exudation of mucus from the body. That there is a secretion from the whole body and not only from the posterior region is demonstrated by carmine which adheres in fine particles to all parts of the animal.

It was shown by Schewiakoff that there are tiny pores between the longitudinal ridges. These probably serve as exits for the secretion. The longitudinal ridges carry it backward and away after it has served its usefulness in effecting motion. The secretion is in the form of threads simply because it is constricted into narrow lines by passing backward between the tiny ridges. The threads are not necessarily continuous but may be often broken.

Thus I am of the opinion that the secretion at the posterior end of the body does not produce motion, but that it is a waste product by the time it has reached this end; it is likewise effective as shown above in inhibiting motion in an unnatural medium, as well as in producing it.

Besides the simple progressive movement, a twisting or bending movement is commonly observed. The body bends often with little or no change of position. This bending involves chiefly the anterior half of the deutomerite. The protomerite is turned from side to side like the head of a higher animal while the parasite is progressing from place to place. The protomerite, of itself, apears however to be incapable of movement and not the slightest change in form has been noticed. The region of greatest capacity for motion is the anterior end of the deutomerite. The endocyte of this region flows out into small pockets made in the elastic epicyte and as a group of two or three small outpushings is made on one side, close together, the protomerite falls to the opposite side. An outpushing of several small pockets just below the bent over protomerite tends to straighten it; if half a dozen or more are formed in a circle around the anterior end of the deutomerite, the protomerite will sink into the central depression and often be obscured from sight.

The parasite is able to move through a place much narrower than the width of the body by the contraction and expansion of the epicyte, as in the instance of an amoeba.

Bending movement when the animal is out of its normal habitat may be due to external stimuli such as the endeavor to avoid light and the water medium. When in the normal habitat, the animal does not need to move about in search of food, there is no light to avoid, and the chief function of the bending movement when the parasite is in the intestine is probably the formation of a cyst. Two animals rotate about an imaginary axis coming closer and closer together by bending more and more, and finally form a perfect sphere (see Figures 234, 235 and 238). The formation of cysts by the use of normal saline occurred in twenty-five minutes. The salt solution was removed as soon as the cyst was completely formed and the cyst washed with distilled water. It developed to completion with the exudation of ripe spores. Cysts have, however, developed in but little longer time in distilled water.

SUMMARY

1. Normal salt solution is the best artificial medium in which to study motion.
2. Locomotion is effected by means of a progressive, gliding movement with no apparent localized motion of the body.
3. Progression takes place at the average rate of 0.8 per second in *Leidyana erratica.*
4. In artificial media there are formed gelatinous threads at the posterior end of the deutomerite.
5. These threads may be seen with a high power and a minimum amount of light in a mount which has been made for some time.
6. They do not occur in a freshly made mount.
7. The threads may be demonstrated with carmine granules in suspension.
8. The animal probably moves by imperceptible vertical movements of the myonemes of the side which is ventral at the time, and upon a surface whose friction is caused by an exudation of slime from the body of the parasite.
9. This mucus is secreted by the body and runs out through pores between the longitudinal ridges in the epicyte.

10. The mucus runs backward along the longitudinal ridges to the posterior end and is discharged as a waste product in the form of broken threads or strands.
11. The anterior half of the deutomerite is the region chiefly involved in bending movement.
12. The protomerite is incapable of independent bending movement.
13. The normal object of contortion is the formation of cysts.

PART II

MORPHOLOGY OF GREGARINES

MORPHOLOGY OF THE SPORONTS

The structural characteristics of the Gregarines have been described by many writers, including Delage and Hérouard (1896), Bütschli (1882), Minchin (1903, 1912), Doflein (1911), and others. For this reason I have not attempted to describe the general morphology of the group but rather to state facts of form and structure which I have observed in the two families under observation, viz., the Stenophoridae and the Gregarinidae.

The Stenophoridae

All of the species of this family are solitary. In all gregarines which reproduce sexually, the union of two sporonts is necessary but in the Stenophoridae this intimate association lasts only while the cyst is being made and not, as in some families, during the greater part of the sporont life. The cyst is probably formed quickly and this union very brief; no sporonts were seen in the process of cyst formation.

One characteristic of almost all the described Stenophoridae is the great length of the deutomerite as compared with the protomerite. The ratio is seldom less than 10:1 and is often as high as 30:1.

The protomerite is not constant in shape; it is, however, generally more or less conical, rounded at the apex, either as a simple cone (Fig. 7) or constricted or dilated slightly halfway from apex to base (Figs. 14, 16, etc.); there is generally, but not always, a small papilla at the anterior end (Fig. 24). The epimerite, which is superimposed upon the protomerite of the cephalont, contains some endoplasm which is continuous with that of the protomerite through the narrow neck connecting epimerite and protomerite. At the apex of the protomerite of the sporont, i. e., an individual which has lost its epimerite, the epicyte is very thin and the endocyte reaches nearly to the top. When the epicyte of the sporont upon the slide is ruptured, this rupture takes place at the apex and is accompanied by an extrusion of protoplasm at this point; the endocyte breaks first at its weakest place and in this family the apex of the protomerite is the weakest point. The thinness of the ectoplasm at the apex gives rise to the idea that there is a pore here.* I am of the opinion that there is no pore but that the epimerite severs its connection with the trophozoite by gradual constriction at its short neck and drops off as a ball. The apex of the protomerite closes over completely, leaving a trace of the narrow channel in the epicyte by which the endoplasm of the two parts was in connection. That there is an opening to the exterior at this point in the sporont seems doubtful for I have never seen the extrusion of endoplasm in a freshly taken sporont to which slight pressure was applied; it occurred only when the animal had been kept on a slide in a normal saline or water medium, and then only after from fifteen minutes to an hour, or until the decrease in the density of the outside medium had had time to affect the parasite.

Not all protomerites of the Stenophoridae are conical in shape. In *Stenophora brölemanni* Léger and Duboscq (Fig. 13) the protomerite is shaped like a flattened cork fitting into the neck of a bottle, the deutomerite surrounding it in a thin layer nearly to the apex; in *Stenophora spiroboli* Crawley it is almost hemispherical in shape (Fig. 70).

In sporonts of the Stenophoridae I have seen, the deutomerite is long and slender. Léger and Duboscq record dimorphism in several species, *Stenophora silene* (Figs. 22, 23), *S. chordeume* (Figs. 24, 25), *S. varians* (Figs. 16, 17), etc., wherein the sporonts are both elongate and subglobular in shape. However, I have not observed an authentic and unquestionable case of dimorphism. The long, slender sporonts are, nevertheless, able to contract so as to be of quite a different shape from the normal. Immature specimens of several species are subglobular and stain more deeply than the sporonts but no mature subglobular specimens have been seen.

There is generally a constriction at the septum which distinctly differentiates protomerite and deutomerite; this is lacking in *Stenophora spiroboli* Crawley (Fig. 70) and in *S. robusta* Ellis (Fig. 26), and is only slightly developed in *S. polydesmi* (Lankester). The widest part of the deutomerite is generally the anterior third; sometimes the deutomerite is a cylinder more or less equal in width throughout. A combination of the two shapes is seen in *Stenophora diplocorpa* (Fig. 21), in which the deutomerite gradually broadens and then contracts in the anterior half, being conspicuously constricted at the middle and cylindrical posterior to the constriction. The deutomerite terminates in a broadly rounded, truncated, or conical extremity.

The protomerite and deutomerite differ greatly in endoplasmic content, and therefore in color and consistency. The protomerite is always the less dense, being often nearly or quite transparent; the granular content is sparse and the large irregular granules are often clustered near the septum, the rest of the space being filled with a colorless fluid. The two parts differ in staining reactions also. The deutomerite contains fairly homogeneous endoplasm always densest at the center of the mass, which is generally in the anterior third of the body. In the posterior part of the attenuated forms, there is often so little endoplasm that the animal is transparent in the last fifth to third of its body. The deutomerite is generally gray or black in its densest regions and a lighter gray in regions of less density.

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*As stated by Ellis (1912b) in the Diplopoda.

The nucleus may be either spherical or ellipsoidal in the sporonts, and varies considerably in relative size in different species. It generally contains one karyosome in mature sporonts of this family, sometimes more than one, but never many, and the karyosomes stain deeply, often revealing the presence of one or two very small centrioles within.

Longitudinal striations in the epicyte seem to be characteristic of the family, and myonemes have been observed in a great many instances. See figure 243 for these structures in *Leidyana erratica,* one of the Gregarinidae. It is probable that both types of structures are invariably present in motile gregarines and form the material foundation for prevailing ideas as to the cause of motion.

The epimerite seems to be an inconstant factor. Sometimes it is well developed and even retained in specimens free in the lumen of the intestine *(Stenaphora nematoides,* Fig. 15; *S. diplocorpa,* and *S. lactaria).* Generally, however, workers who have not sectioned the intestines of hosts have failed to find any trace of an epimerite. This is possible from the fact that development is intercellular and not extracellular as in the Gregarinidae, in which family the epimerite alone penetrates the cell. The whole trophozoite lies embedded and is able to obtain nourishment by osmosis, just as it does when it becomes a sporont, taking food in the former instance from the cell originally penetrated and those surrounding rather than from the lumen. Often intercellular parasites are found without epimerites (Léger and Duboscq, 1904, Pl. XIV, Figs. 1, 3, 4) and yet in the same section there may be smaller specimens which show the epimerite. The reason for the presence of an epimerite at all is not evident unless it is an ancestral vestige, for it disappears while the animal is still living an intercellular existence.

The larger embedded trophozoites are found in various positions in the host cells, generally, however, headed away from the lumen, i. e. with their protomerites contiguous with the mesothelial lining of the intestine. Infrequently one is met which has the protomerite turned toward the lumen (Léger and Duboscq, 1904, Fig. 6). Individuals of *Stenophora lactaria* have frequently been found boring their way, protomerite first, through the mesothelial walls of the intestine into the coelom, and in sections of the host some specimens have actually been found in the coelom lying close to the coelomic epithelium of the intestine. During the boring process the muscular tissue in the wake of the parasite is destroyed, leaving the surrounding tissue shredded and contorted.

The adult parasites seem to prefer lying loose between lobes or clusters of intestinal cells rather than living in the open lumen. The interstices of the lobes are very frequently occupied by large adult gregarines.

The sporozoite is spindle shaped and swells in the lumen. It penetrates the free end of a cell between the cilia and undergoes development within the cell. The first trophozoic stage I have seen is the small, completely formed body without a protomerite, lying embedded with its epimerite at the distal end of the cell next to the mesothelial layer. It undergoes considerable growth here with the consequence that the cell is destroyed and the parasite comes to lie in a self-formed cyst between two cells, often affecting parts of these cells and causing the cells for some distance around to be greatly compressed. Then the epimerite disappears and the protomerite develops and becomes more or less flattened against the basement layer of the cell. The trophozoites emerge into the lumen through the space left by the originally destroyed cell. The nucleus of the trophozoite of *Stenophora lactaria* is spherical; it begins however to acquire its ellipsoidal form while still in the intercellular stage.

The Gregarinidae

The parasites of this family become associative while they are quite immature and long before they are ready to form cysts. The shape of the sporonts remains fairly constant whether they are young or fully mature. The sporonts of the genus *Gregarina* are always more or less obese, and very frequently dolioform. The protomerite is much larger than in the Stenophoridae in comparison to the size of the body. In length, it varies from one-half to one-eighth the total length of the body. It is frequently hemispherical and as often cylindrical, rounded in front, but it is more than twice as high as wide; it is rarely conoidal. There is sometimes a slight indentation at the apex.

The epicyte is fairly thick throughout but is thicker at the anterior end of the body and at the septum than elsewhere.

The deutomerite is nearly always wider than the protomerite. It is fairly regular in shape throughout the family, being generally widest at the middle or slightly anterior thereto and gradually tapering both anteriorly and posteriorly. The posterior end is always rounded; it is never sharply acute.

The endoplasmic content of the protomerite and deutomerite differ more in density than in character of the granules. The protomerite contains homogeneous granules about the same size and consistency as those of the deutomerite but fewer in number, rendering this portion always less dense.

Myonemes are difficult to detect in the Gregarinidae, even with an oil immersion objective, when the animals are alive. They can be seen in longitudinal sections of adults as large deeply stained dots seemingly larger protoplasmic granules, situated at the edge of the endoplasm (Fig. 232). Cross sections naturally do not reveal their presence. In total mounts and with an intravitam stain they can be seen as a delicate network of fibrillae extending around the animal (Fig. 243).

Longitudinal striations in the epicyte are rendered visible by simply crushing the animal on the slide and liberating the dense endocyte. They are very delicate parallel striations visible with the oil immersion lens and situated on the outside of the epicyte. They may be seen in both protomerite and deutomerite and traced continuously from one end of the animal to the other (Fig. 243). They do not converge at the anterior and posterior ends, being continuous over the ends as at other parts of the body. The writer has never seen between the striations the pores which Schewiakoff says serve for the extrusion of the mucus.

The nucleus in the genus *Gregarina* is always spherical. In the trophozoites and in immature sporonts there is often but one large karyosome and never more than five or six. As the size of the animal increases, the karyosomes increase in number and decrease in size and are scattered irregularly throughout the nucleus. In mature sporonts they are often arranged in a twisted chaplet and are then too numerous to count. One of the reasons why maturity of the cyst and its dehiscence in the Gregarinidae occupies so short a time (two days) may be that the nucleus of the mature sporonts has already broken up into numerous small elements before cyst formation has taken place and only needs to lose its wall while in the cyst for these particles to surround themselves with a portion of the sporont endoplasm and becomes gametes. In the Stenophoridae, the nucleus of a mature sporont contains but one large karyosome which after cyst formation has taken place must break up into constituent elements.

The epimerite of all the Gregarinidae in which it has been observed is a large globular slightly stalked or sessile structure which is often retained after its usefulness is gone and the trophozoite is liberated in the lumen (Figs. 224 to 227). There is little endoplasm present in the nearly transparent epimerite which can be demonstrated with an intravitam stain.

LIFE HISTORY OF A TYPICAL CEPHALINE GREGARINE

The life history may be outlined briefly as follows: Sporozoite—trophozoite—sporont—gamete—zygote—spore—sporozoite. The sporozoite is a very minute falciform body liberated from the spore by the action of the digestive juices of the host which has swallowed it.* This small body apparently possesses no means of locomotion other than the extrusion of protoplasm. It lodges among the cilia of the intestinal epithelium and bores its way into the cell by ameboid movement. (Léger and Duboscq, 1909). Penetration is probably effected by the excretion of a toxin which lowers the resistance of the cell wall. It either merely punctures the wall and projects a small portion of its body into the cell, as in most Gregarinidae, or completely embeds itself in the cell mass, deriving its nourishment from the cell sap, as in the Stenophoridae. As soon as the sporozoite begins to absorb nourishment and to grow, it becomes a trophozoite. A combination of factors determines when the trophozoite shall be liberated into the lumen of the cell. The destruction of epithelial cells and the growth of the parasite go hand in hand and when the cells no longer supply sufficient nourishment or when the activity of the parasite causes it to release its hold, the trophozoite is liberated into the intestine and thenceforth absorbs nourishment from the fluids of that cavity.

After the cell has been destroyed and the parasite liberated, the epimerite is no longer useful and drops off. With the loss of the epimerite and change in habitat, the animal becomes a sporont. At some stage in sporont life, generally an early one, a member of the genus *Gregarina* attaches to one end of the body another sporont, the two forming an association. In genera in which the sporonts are solitary, attachment of two sporonts takes place just previous to cyst formation. Upon reaching a certain size or density or because of some unknown internal factor, the two sporonts rotate about a common axis and form a sphere. This spherical mass acquires a relatively thick gelatinous covering, the cyst, and leaves the body of the host with the feces. If it remains in a moist place for 48 hours, development proceeds as follows: The sporont nucleus breaks up into a myriad of small chromidial bodies, each small body acquiring a small amount of the residual protoplasm of the sporont. These nucleated particles are gametes. The gametes of the two sporonts are allowed to mingle by the beaking down of the separtion walls, when they fuse two by two and form zygotes. The zygote acquires a tough, resistant transparent covering and the content breaks up into eight parts, each with a portion of the zygote nucleus. The resulting body is an octozoic spore. The spores are liberated from the cyst through spore ducts which are formed from the residual protoplasm of the cyst. They are scattered over the grass and ground by the wind and rain and are eaten by some host along with its food. Parasitism is thus accidental. The spores upon reaching the alimentary canal of the host are acted upon by the digestive juices and the spore wall absorbed. Upon the disappearance of the wall, the eight sporozoites are set free and the life history starts on the same cycle again.

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*There is some evidence to substantiate the theory that autoinfection occurs and accounts for the enormous number of parasites which is often present in a host. See last page of section on cysts.

THE QUESTION OF SPORONT MATURITY

The question may be raised in connection with the development of the sporonts and cysts: Can one detect a sporont which is fully mature and ready for cyst formation? After many months of observation upon a number of species of several genera, I have come to the conclusion that full maturity can be detected and the imminent cyst formation predicted. In a genus like *Gregarina,* in which the association of sporonts is a characteristic feature, the fact that specimens are in associations of two does not indicate that the sporonts are mature, for associations are often formed early in sporont life while the animals are very small and obviously immature. In fact many sporonts are seen in association which are much smaller than some cephalonts of the same species free in the intestine. The fact that sporonts are linked together in twos is not an indication of maturity.

Density of the animals is often a criterion of maturity but not one upon which to depend. Cephalonts are transparent or nearly so; the small sporonts are but slightly opaque and opacity increases steadily with age, the oldest in many species being very dense and practically black in transmitted light. If, however, a host is starved a few days before being opened, the parasites are likewise starved and become more or less transparent.

Size increases with age and only the large individuals in any case may be expected soon to form cysts.

While no one of these three characteristics can be used as a test of maturity of the sporonts, an association of large sporonts in which the individuals are well filled with protoplasmic granules and hence opaque, indicates without doubt that the sporont is mature.

Movement of such an association is no longer the active motion of translation; the sporonts have become sluggish and tend to revolve. When the revolution becomes fairly well established, it takes a spiral form and gives place to rotation. The animals finally become a compact spherical mass with a cyst wall which has been secreted during rotation. The sporonts are now in position to reproduce themselves.

THE CYSTS

Observations on cyst formation and development, like those on movement have been confined chiefly to one species. In the Stenophoridae I have not been able to procure the dehiscence of any cysts; in the Gregarinidae observed, however, it was an easy matter to procure cysts and watch their development. Cysts were taken from moistened fecal masses or from the intestine by means of a needle and placed on slides. Bits of broken glass were used to raise the cover slip, and distilled water added. The cell was sealed with vaseline and placed in a petri dish well vaselined along the edges.

Cysts of the Stenophoridae observed were spherical or slightly ellipsoidal. They are generally found in the posterior part of the intestine and were not seen until fairly developed and rotation had ceased. It is not difficult to determine in most cases that two individuals were involved in making the cyst. The line of separation is often indicated in the cyst and there is often a slight difference in density of the two conjugants. In one instance one sporont was nearly black and the other pale tan. This fact was not noted until after the cyst had been in the damp chamber half an hour. In all cases observed the cysts became lighter in color after being in the damp chamber a few hours. In freshly opened intestines, cysts do not show a clear hyaline layer but after exposure the extrusion of water causes the inner mass to shrivel and the epicyst to swell so that the whole diameter is greater than at first. Although cysts were kept in the damp chamber nine days no spores developed. Whenever still intact, the cysts were crushed at the end of that time but there was no apparent differentiation of the protoplasm and none was revealed by staining. Most of the cysts were, however, shriveled and disintegrated.

Cyst Formation in the Gregarinidae—Leidyana erratica

This species is in its normal sporont stage non-associative. The young sporonts which have but recently lost their epimerites are nearly transparent but as age advances density increases, due to the absorption of food. The oldest sporonts are very dense and practically black in the deutomerite so that the nucleus is not visible when they are alive. The body in the young sporonts is long and rather slender, but it widens appreciably in the older ones. Middle-aged animals are very active in their movements but older ones are sluggish and tend to lie motionless in masses (Fig. 230).

In dense, sluggish individuals, one may expect cyst formation to take place. The sporont retains its power to bend and twist after it has apparently ceased to use its progressive powers. Sluggish individuals in rotation set in motion currents in the surrounding medium and slowly attract into this ever-widening circle of influence particles of debris or nearby gregarines. If debris is drawn into the whirlpool, it is not retained, but slips to the outside again. Another gregarine is, however, attracted and held probably because of the mucus on its exterior, and caused to rotate with the first one. If two gregarines are attracted, the force exerted by the first is too weak to hold both and one is invariably liberated. A sporont is apparently unable to make a cyst alone. A single sporont has been seen to rotate for three hours without succeeding in attracting another and then to straighten out suddenly and move to another part of the field.

When such an association is formed, the sporonts are not attached by particular parts of the body, as are associations of the genus *Gregarina,* but are held together in a haphazard fashion by secretions only. In rotation the sporonts come closer and closer together laterally, slipping by a few sudden jerks until one does not project beyond the other, the protomerites bend around so as to meet the posterior ends of the deutomerites (Figs. 234 to 236), the deutomerites projecting and contracting so as to leave no unfilled interstices until the result is a compact sphere. In one such process, there was formed in the middle of one side of each deutomerite a tiny cupped indentation and the two cups fitted together to form a perfect sphere. This sphere became smaller and smaller as the cyst developed and finally disappeared in the general breaking down of the inclosed sporont walls (Figs. 235, 238).

The mass continues its slow rotation for hours. After a compact mass has been formed one can still distinguish the nuclei and the protomerite and deutomerite of each sporont, the former by the pale tan color (Figs. 239, 240). This demarcation is lost and soon after the faintly visible lighter nuclear areas disappear. The straight line which separates the two sporonts (their lateral walls) remains visible for twenty-four hours after the cyst has begun to form. It disappears finally and the cyst-mass becomes perfectly homogeneous throughout (Fig. 241).

All the time the mass is revolving there is being exuded from the two bodies the sticky, gelatinous, transparent secretion. This exudation follows the animals as very slender spiral threads and forms a spirally arranged layer constantly increasing in width as rotation continues. When rotation ceases there is formed around the cyst-mass an appreciable layer of this gelatinous matter arranged as very fine concentric threads.

Motion of the mass was watched in one instance to completion. My notes opposite the time of each successive complete rotation read as follows: ''Brings another gregarine into the vortex; the two rotate together; shoves a third gregarine out of the way; retracts same; the two slip and slide until they form a perfect sphere; central spherical area left between the two sporonts; gelatinous layer forming around the rotating sphere ;the outer layer wider and distinct.'' The time for the first complete rotation of the solitary individual was one and one-eighth minutes. Approximately this rate is retained during sixteen rotations. The rotations then becomes slower as the mass more and more nearly approximates a sphere. Two and one-half minutes, four minutes, and five minutes are recorded for successive rotations. At the end of forty-five minutes the cyst was complete but still slowly rotated at the rate of one rotation in from four to five minutes. When next observed, two hours later, motion had ceased and there was present a gelatinous layer in thickness one-third the radius of the cyst.

Fully formed cysts which are still in the process of rotation were frequently taken from the host and they continue to rotate a half hour or more after removal.

Cyst Development and Dehiscence

When the mass has finished rotating, it is a beautifully homogeneous, opaque, gray spherule surrounded by a thick, transparent, cyst wall fifty micra in thickness or half the radius of the inner mass. The mass begins to disintegrate in twelve to fifteen hours, the protoplasm becoming arranged in many dense areas (Fig. 242). The diameter of the inner mass decreases and that of the transparent cyst wall increases by the exudation of water from the inner regions. In twenty-four hours the protoplasm within the cyst wall has begun to shrink from the periphery. Five hours later (29 hrs.) the spore ducts are clearly indicated (Fig. 245) by dense accumulations of protoplasm on the periphery or orange colored discs on the cyst surface. From three or four to a dozen of these discs are delineated. The orange color is due to an accumulation of orange colored oil which dissolves and loses its color in ether. Soudan III stains it red. The oil can be pressed out from the cyst in large globules. The origin of this oil in the cyst is, of course, the endoplasm of the sporonts. The protomerite is tan in color and probably contains considerable oil; the deutomerite may contain as much or more but the color is obscured by the great number of protoplasmic granules which render the whole very opaque.

After thirty-five hours, the ducts leading from the periphery to the center of the cyst mass appear; they resemble the spokes of a wheel. In a few more hours the spore ducts begin to project from the surface of the sphere; the center is depressed (Figs. 247, 248). By this time the individual spores are visible within the mass (Fig. 246). At the end of from forty-two to sixty hours, the spores are liberated (Fig. 249). Although from one to a dozen spore ducts begin to grow outward, not more than one has been seen to complete itself. This is accounted for probably by the fact that pressure is exerted on most of the incipient ducts by the slide and cover slip, and growth to completion thus inhibited. One duct is often directed horizontally between the two surfaces and it always is this lateral duct which develops and through which spores are extruded. When there is considerable debris in the vicinity of the developing cysts, the ducts are often coiled and twisted about the cyst itself. I have never been able to incite spore exudation without the use of a cover slip for even in a carefully sealed damp chamber there is enough volume within the chamber to cause sufficient evaporation to dry up the unprotected cyst.

The duct which is formed is very long, 25 mm. or eight times the radius of the cyst (Fig. 249). The ducts grow inward from the periphery where they first appear to the region of the residual mass of protoplasm. Then they grow outward from the periphery until they acquire the enormous length attained in a few species. The growth outward is from the region of the periphery, the older portion being pushed ahead. The tip of the long duct is orange colored as is the disc from which growth began, showing that the oil globules are pushed along with the first outpushing of the tube. There does not seem to be an eversion of the duct here, as in *Gregarina rigida* and other species (Lankester, 1903:183).

The spores emerge in chains which soon break up into small segments. These spores (Fig. 255) are barrel-shaped and truncate at the ends. They possess an epispore and endospore easily discernible when a stain is used on the slide. They are slightly cupped at the ends. I think there is a corona of very delicate spines or cilia at each end which serves to hold the spores together in chains and to furnish a means of locomotion for the isolated spores. That spores do move from place to place is easily determined by watching a few chains of freshly liberated spores on a slide. (Care should be taken that the slide is undisturbed and not allowed to evaporate). In a few hours no two spores will be left attached but they will lie in small clusters or scattered over a whole field.

Sometimes spore ducts do not develop and the cyst has superficially undergone but little differentiation, yet upon crushing the walls after a day or so when the spore ducts should have been formed, perfectly formed spores emerge, to all appearances and staining reactions identical with those liberated in the usual way. Nothing could be said of their potency as compared with those extruded normally.

The content of the spores varies greatly. If the cyst is broken before the spore ducts have had a chance to form, and apparently before the spores are ripe, they will be found to contain many small clustered or isolated chromosomes which stain deeply. All the spores from a given cyst are in approximately the same stage of development. Another broken cyst will yield spores with fewer chromosomes, from ten to fifteen, for instance. A cyst brought to completion yielded spores in which each of the many examined contained eight large chromosomes. These spores were watched for a day and at the end of the twenty-four hours delicate partitions were seen, between each two of which was contained one large chromidial body. These partitions represented lines of separation between the eight sporozoites which were being developed (Fig. 255). I was unable to procure or find any liberated sporozoites by any of the following methods: 1) Some spores were left on the slide in a water medium; 2) others were placed in normal sodium chloride solution; 3) the intestinal juice of a freshly killed cricket was run under a third cover slip on which were a few spores; and 4) spores were placed on a small mass of fresh intestinal epithelium. In the last two instances putrefaction was soon set up in the non-sterile tissues. Using spores of another gregarine *(Frenzelina delphinia)* from a crab, I sterilized some of the colorless blood from the heart of the crab by boiling it in a test tube and used the liquid as a medium but without inciting spore development.

Cysts were crushed at various developmental stages and stained. The spores were found to be well developed before the spore ducts were formed, so the early stages of development are the sources of greatest changes.

Immediately after the protoplasm of the cyst becomes collected in masses, small clear papillae begin to appear on the periphery of each mottled mass (Fig. 244). The layer of papillae being formed, another develops beneath, until the three or four outer layers of the cyst show these papillae, the inner mass being residual non-metamorphosed protoplasm.

The papillae soon become pinched off to form tiny globular bodies, each of which contains a deeply staining particle inside. These globular bodies are the gametes (Fig. 251). Upon crushing and staining a cyst in the gamete stage, I have repeatedly been unable to find the least evidence of a difference in shape or size or in staining reaction between the gametes from opposite poles of the cyst; i. e., from each of the two constituent sporonts. The gametes are isogametes. That there is, however, a difference between them is shown by the attraction of certain gametes for others. Before the partition wall between the two sporonts is absorbed, the gametes of each side do not attract others from the same side of the partition. But when the partition wall has dissolved and the cyst is examined, it is seen to contain many 'double' gametes; i. e., gametes united in pairs (Fig. 252). If taken early enough, the gametes are seen to be barely contiguous at one point. The next stage observed is that in which each retains its identity but is flattened on the side of attachment to the other (Fig. 253). Then the identity of each becomes lost and the result is a body twice the size of the original gamete, with a nuclear content made up of the fusion of that of the two gametes. This larger body, which in staining reaction is identical with that of the gametes, is the zygote. In a cyst of twenty-four hours, no spore ducts had begun to appear but the cyst was full of zygotes.

The zygotes when fully formed are ellipsoidal in shape, contain many small deeply staining bodies, and possess a rather thin wall (Fig. 234). They develop gradually into spores. The outline becomes more spore-like by the gradual flattening of the ends and the decrease in the number of chromidia while the outer wall increases in thickness. In a cyst of about thirty hours the zygotes have attained the shape of the ripe spores but the content is still that characteristic of the zygote.

From the thirtieth hour on, the chromidia rearrange themselves and decrease in number by fusion, and the perfection of the mechanism for expelling the ripe spores proceeds.

It is probable that the cyst can develop and spores be expelled while within the intestine, possibly resulting in the reinfection of the host and accounting for the enormous numbers of parasites found in some hosts. I have seen cysts dense and opaque, cysts pearl gray and mottled, and even cysts with spore ducts well developed and nine in number, all within the body of a freshly caught cricket. The same advanced stages of the cysts of another species have been found in the bodies of freshly opened locusts and also in certain Crustacea.

PART III

Synopsis of the Eugregarine Records of the Myriapoda, Coleoptera, and Orthoptera of the World

INTRODUCTION

The synopsis and list of parasites which follow were made in order to obtain the essential features of all the known species of eugregarines parasitic in three groups of animals so that in placing on record some twenty odd species which I had found during the last year there would be no danger of redescribing a species under a new name or of describing a new species under a name already used. It is hoped that the synopsis will be useful to future workers.

Species have been included from the whole world and not from the United States only, for many species of protozoa are notably cosmopolitan and not restricted to definite areas. The study of gregarines is as yet scarcely begun in the United States and very few species have been found both in the Old World and in the New, but workers in the United States must be on the lookout for Old World species and should not describe forms new to this country as actually new species without considering the parasites of other regions of the world.

Every effort has been made to include in the synopsis all the species mentioned in the literature. Sources of information are as follows: Dufour (1837), Kölliker (1848), Stein (1848), Frantzius (1848), Diesing (1851), Lankester (1863), Minchin (1903), Labbé (1899), Sokolow (1911), Ellis (1913b), indices of the Zoologischer Anzeiger from 1878 to 1895, cards of the Concilium Bibliographicum from 1895 to date, and current periodicals: Archiv für Protistenkunde, Archives de parasitologie, etc., for the past and present calendar years. To a great extent these references have acted as checks on each other although the original sources have not infrequently revealed other species not elsewhere mentioned. Many of the older species recorded in this synopsis do not appear in Labbé's Sporozoa.

Labbé repeatedly regards as synonyms species which occurred in the same host genus or in allied genera without regard to whether or not the species of parasites were identical. In most instances the species are not the same although the same species or genus of host is involved; such unlike parasites have been separated. For example, *Phialoides ornata* Léger and *Gregarina brevirostra* Kölliker were regarded as synonymous because they infect the same host. In some instances Labbé regarded as synonymous species which actually belong together; for example, *Actinocephalus lucanus* Stein and *Stephanophora radiosa* Léger, which are identical, the species now being known as *Actinocephalus conicus* (Dufour) Stein.

The law of priority has been adhered to strictly and many parasites known by later assigned names have been referred to names given to them many years before, e. g. *Actinocephalus conicus* which was long known as *Actinocephalus lucanus.* Labbé in most instances calls such species by the later assigned names in his treatise.

In the descriptions of species, well developed sporonts have been taken as the standard except where such have not been described, these rare instances being noted in the synopsis. Shape of the cephalonts is often quite unlike that of the sporonts and thus of no systematic value in diagnosis. Whenever the epimerite is not mentioned in the literature, as is often the case, the generic determination of the author is based on other characters. The sporonts are often polymorphic and the synopsis records are based on expanded, quiescent, and, as far as known, normal specimens except where the polymorphism is marked. In these instances such facts are noted.

In the description of each new species, I have given measurements of only a few large, typical sporonts. These are taken from records of the measurements in most instances of twenty-five or more animals. In most published descriptions the length and width of one sporont only is stated, generally of the largest one observed and the ratios of various parts are based on this one parasite.

As the discovery of new species proceeds, I am of the opinion that many will be very similar to others already described and not easily differentiated from them unless a wide range of measurements and ratios is taken from parasites in different hosts and selections made therefrom for use as a table. This applies in particular to the genus *Gregarina,* where differences between species appear to be limited. One observer might find the maximum length to be a and the ratio of the two parts as 1:2. Another worker on the same species might find his largest specimen to be $2a$ long and the ratio of parts as 1:3 and describe the species as different from the former. A table showing lengths and ratios selected from measurements of many parasites in the same host and from as many hosts and under as varying conditions as possible (habitat, season, etc.) eliminates the danger of duplication of species.

I have differentiated new species in the same genus by the following characteristics: Size, both medium and average; ratio of length of protomerite to total length; ratio of width of protomerite to width of deutomerite; general shape of the body; shape of the protomerite; shape of the deutomerite; character of the interlocking device; size and shape of the nucleus; color and character of the protoplasm; and the size and shape of the cysts and their method of dehiscence.

It is true of many species that the family or generic determination or both are uncertain because important diagnostic features such as the epimerite and spores are often lacking. The correct family can sometimes be determined when only one of these factors is present. In some instances the correct genus can be ascribed even though important data are lacking, e. g. the genus *Gregarina,* by its biassociative factor and the host involved. If there is any doubt about the position of a given animal, the parasite is placed at the end of the particular genus to which it may belong.

In describing the associative gregarines, generally only specific measurements of the primite are given for the proportions of satellite differ considerably within the same species as it happens to be more or less flattened while those of the primite remain fairly constant. The shape given for the posterior end of the deutomerite is that of the satellite, where the deutomerite is free at its posterior end; in the primite it is altered by contiguity with the protomerite of the primite.

The species of gregarines indigeneous to each of the three groups are arranged in families, and under each family the genera are placed in alphabetical order. In each genus the species are arranged in chronological order, the oldest first, the latest additions last. New species not hitherto found are described in detail in the groups to which their hosts belong.

In as many instances as possible, the names of the hosts have been checked and corrected to accord with the best authorities. However, this has often been impossible and the names had to be left as in the original citation. Especially is this true of the older species of parasites, many of which have not been found since the original discovery seventy-five years or more ago.

The names of the Myriapod hosts have been corrected, those abroad in accordance with Latzel (1884) and those endemic to the United States after Bollman (1893). Coleopteran literature seems not to be in condition to warrant the finding of synonyms for many of the early described species. For instance, the name by which a beetle is known today will be recorded, but not the name by which it was known some fifty years ago and by which it was called when the parasites infesting it were described. When names have been corrected to accord with present day knowledge, the older name is placed in parenthesis after the now accepted name.

The spelling of the name of the diplopod *Julus* as given by Linnaeus (1766) has been used thruout wherever the word appears, whether in the name of the host or in the name of a species of parasite where the name is used as a prefix. The *Iulus* of some authors is, then, disregarded in the nomenclature of the species.

A BRIEF SYNOPSIS OF THE FAMILIES AND GENERA OF THE TRIBE CEPHALINA (DELAGE) OF THE SUBORDER EUGREGARINAE (LÉGER)

This synopsis is based on the classification of Minchin (1903, 1912) and Poche (1913).

Subphylum Sporozoa Leuckart 1879:241.
- Class 1. Telosporidia Schaudinn. Sporulation ends the life of the individual.
  - Order 1. Gregarinida Bütschli 1882:503. Reproduction by spore formation only or by both spore formation and budding.
    - Suborder 1. Schizogregarinae Léger.
    - 2. Eugregarinae Léger. Reproduction limited to spore formation. Spores octozoic.
      - Tribe 1. Acephalinae Kölliker (Monocystoidae Poche).
      - 2. Cephalinae Delage 1896:269. Eugregarinae with an epimerite at some stage in the life history. Body usually divided by septum into protomerite and deutomerite. Spores with two coats. Mainly parasitic in the gut of arthropods.
        - Family 1. Didymophyidae Léger 1892:105. In associations of two or three. No septa in satellites.
          - Genus 1. Didymophyes Stein 1848:186. Characters of the family. Epimerite a small pointed papilla, cyst dehiscence by simple rupture. Spores ellipsoidal.
        - Family 2. Gregarinidae Labbé 1899:9. Associative or solitary, satellite with septum. Epimerite symmetrical, simple. Cysts with or without spore ducts.
          - Genus 2. Gregarina Dufour 1828:366. Biassociative. Epimerite small, globular or cylindrical. Spores dolioform to cylindrical. Cysts dehisce by spore ducts.
          - Genus 3. Hirmocystis Labbé 1899:12. Associations of from two to twelve or more. Epimerite a small cylindrical papilla. Cysts dehisce by simple rupture. Spores ovoidal.
          - Genus 4. Hyalospora Schneider 1875:583. Biassociative. Epimerite a simple globular knob. Cysts dehisce by simple rupture. Spores ellipsoidal. Endoplasm yellow-orange.

Genus 5. Cnemidospora Schneider 1882:446. Solitary. Epimerite not known. Anterior half of protomerite gray, posterior half yellow-green. Dehiscence of cysts by simple rupture. Spores ellipsoidal.

Genus 6. Euspora Schneider 1875:582. Biassociative. Epimerite not known. Cysts dehisce by simple rupture. Spores prismatic.

Genus 7. Sphaerocystis Léger 1892:115. Protomerite only in young stages. Solitary, subspherical. Dehiscence by simple rupture. Spores ovoidal.

Genus 8. Gamocystis Schneider 1875:587. Protomerite only in young stages. Associative. Sporulation partial, with spore ducts. Spores cylindrical.

Genus 9. Frenzelina Léger and Duboscq 1907:773. (Cephaloidophora Mawrodiadi 1908:101). Biassociative. Epimerite not known. Cysts dehisce by simple rupture. Spores ovoidal, with dark equatorial line. Intercellular development.

Genus 10. Uradiophora Mercier 1912:198. Bi- or triassociative. Epimerite simple style, forked at end. Cysts dehisce by simple rupture. Spores dolioform.

Genus 11. Leidyana Watson 1915. Solitary. Epimerite a simple globular sessile knob. Dehiscence by spore ducts. Spores dolioform.

Family 3. Dactylophoridae Léger 1892:165. Epimerite complex. Sporonts solitary. Cysts dehisce with lateral pseudocyst or by simple rupture. Spores elongate, cylindrical or ellipsoidal.

Genus 12. Dactylophorus Balbiani 1889:41. Protomerite dilated laterally with peripheral digitiform processes. Sporonts solitary. Spores in chains obliquely.

Genus 13. Nina Grebnecki 1873:—. Protomerite formed of two long narrow horizontal lobes fused and upturned spirally at one end. Periphery set with teeth from which project long slender filaments. Spores in chains obliquely.

Genus 14. Trichorhynchus Schneider 1882:438. Epimerite a very long slender neck with dilation on surface. Lateral pseudocyst for dehiscence. Spores cylindrical or ellipsoidal, not in chains.

Genus 15. Echinomera Labbé 1899:16. Epimerite an eccentric cone with eight or more short digitiform processes from sides. Dehiscence by simple rupture. Spores cylindrical, in chains.

Genus 16. Rhopalonia Léger 1893:1285. No protomerite in sporonts. Epimerite a subspherical cushion with ten or more short thick digitiform processes. Pseudocyst. Spores cylindrical.

Genus 17. Acutispora Crawley 1903:632. Epimerite not seen. Pseudocyst. Spores biconical, thick blunt endosporic rod at each end.

Genus 18. Metamera Duke 1910:261. Epimerite subconical, apex eccentric, surrounded by numerous branched digitiform appendages. Dehiscence by simple rupture. Spores biconical.

Family 4. Actinocephalidae Léger 1892:166. Sporonts solitary. Epimerites varied. Cysts dehisce by simple rupture. Spores irregular, biconical or cylindro-biconical.

Genus 19. Actinocephalus Stein 1848:196. Epimerite small, sessile or on a short neck, with 8 or 10 short sharp spines or simple bifurcate digitiform processes. Spores biconical.

Genus 20. Geneiorhynchus Schneider 1875:594. Epimerite a tuft of short bristles set at the apex of a long slender neck. Spores cylindro-biconical.

Genus 21. Pyxinia Hammerschmidt 1838:357. Epimerite a flat crenulate crateriform disc from center of which rises a short or long style. Spores biconical.

Genus 22. Beloides Labbé 1899:27. Epimerite a spiny globule with a long apical style set on a short stout neck. Spores biconical.

Genus 23. Phialoides Labbé 1899:24. Epimerite a broad cushion with peripheral row of teeth and a thickened collar placed on a long slender neck. Spores biconical.

Genus 24. Legeria Labbé 1899:24. Epimerite not known. Protomerite dilated and massive. Septum convex upward. Spores cylindro-conical.

Genus 25. Coleorhynchus Labbé 1899:23. Epimerite not known. Protomerite a round shallow disc depressed in center. Septum convex upward. Spores biconical.

Genus 26. Bothriopsis Schneider 1875:596. Epimerite an ovoidal structure with 6 or more long slender filaments. Protomerite very large, septum convex upward. Spores biconical.

Genus 27. Asterophora Léger 1892:129. Epimerite a thick horizontal disc with a milled border and a stout style projecting from center. Spores cylindro-biconical.

Genus 28. Schneideria Léger 1892:153. (Rhabdocystis Boldt 1910:289). Epimerite like that of Asterophora. Style shorter, no protomerite in sporonts. Spores biconical.

Genus 29. Stictospora Léger 1893:129. Epimerite spherical, centrally depressed, armed with a dozen backwardly directed mucrones set on a short neck. Spores biconical, slightly curved.

Genus 30. Stylocystis Léger 1899:526. Epimerite a recurved sharply pointed cone. Spores biconical.

Genus 31. Steinina Léger and Duboscq 1914:352. Epimerite a short mobile digitiform process changing into a flattened button. Spores biconical.

Genus 32. Taeniocystis Léger 1906:307. Epimerite a small sphere set with 6 or 8 recurved hooks. Deutomerite divided by septa into numerous linear segments. Spores biconical.

Genus 33. Discorhynchus Labbé 1899:20. (Sycia Léger 1892:52). Epimerite a large globular structure with a thin collar around base. Short stalk. Spores biconical, slightly curved.

Genus 34. Amphoroides Labbé 1899:20. Epimerite a globular sessile papilla. Protomerite cup shaped. Spores curved.

Genus 35. Pileocephalus Schneider 1875:591. Epimerite a lance-shaped or simple cone. Spores biconical.

Genus 36. Anthorhynchus Labbé 1899:19. Epimerite a large fluted flattened button. Spores ovoidal, pointed.

Genus 37. Sciadophora Léger 1899:18. Epimerite large, compressed laterally, peripherally crenulate. Protomerite bears numerous backwardly directed mucrones. Spores biconical.

Genus 38. Hoplorhynchus Carus 1863:570. Epimerite a flat button with 8 or 10 digitiform processes carried on a long collar. Spores biconical.

Genus 39. Amphorocephalus Ellis 1913:462. Epimerite dilated in middle, terminating in concave peripherally fluted disc at anterior end. Spores not known. Protomerite constricted across middle.

Family 5. Acanthosporidae Léger 1892:167. Sporonts solitary, epimerite simple or appendicular. Dehiscence by simple rupture. Spores with equatorial and polar spines.

Genus 40. Acanthospora Léger 1892:145. Epimerite a simple conical papilla. Spores biconical or ovoidal with row of equatorial spines and a tuft of four spines at each pole.

Genus 41. Corycella Léger 1892:144. Epimerite globular with 8 large recurved hooks. Spores biconical, 4 spines at each pole.

Genus 42. Ancyrophora Léger 1892:146. Epimerite a globule with 5 or 10 backwardly directed digitiform processes. Spores biconical with equatorial and polar spines.

Genus 43. Cometoides Labbé 1899:29. Epimerite a spherical button with long slender filaments. Spores cylindro-biconical, with polar and two rows of equatorial spines.

Family 6. Menosporidae Léger 1892:168. Sporonts solitary. Epimerite a large cup bordered with hooks and placed on a long slender collar. Cysts dehisce by simple rupture. Spores crescentic, smooth.

Genus 44. Menospora Léger 1892:168. Characters of the family.

Family 7. Stylocephalidae Ellis 1912:25. Sporonts solitary, epimerites varied. Nucleus ovoidal. Dehiscence by pseudocyst. Spores irregularly shaped, brown or black, in chains.

Genus 45. Stylocephalus Ellis 1912:25. Epimerite a dilated papilla at end of a long slender neck. Cyst covered with small papillae and indentations. Spores hat-shaped.

Genus 46. Sphaerocystis Labbé 1899:32. Epimerite a small sphere or ellipsoidal body at end of a long slender neck.

Genus 47. Lophocephalus Labbé 1899:31. Epimerite a large sessile flattened crateriform disc, the periphery crenulate and set at base with numerous short upwardly directed digitiform processes. Spores hat-shaped, black.

Genus 48. Cystocephalus Schneider 1886:99. Epimerite a large lance-shaped papilla set on a short stout cylindrical collar. Spores irregularly shaped.

Family 8. Stenophoridae Léger and Duboscq 1904:361. Development intercellular. Sporonts solitary. Epimerite absent or a simple structure. Cysts dehisce by simple rupture. Spores ovoidal with equatorial line. Not extruded in chains.

Genus 49. Oocephalus Schneider 1886:101. Epimerite a spherical button upon a short conical neck. Spores not known.

Genus 50. Stenophora Labbé 1899:15. Characters of the family. Confined to Diplopoda.

GENERA OF UNCERTAIN POSITION

Genus 51. Ulvina Mingazzini 1891:235.

Genus 52. Nematoides Mingazzini 1891:233. Dicystid, no septum in sporonts. Epimerite forked, situated on a long collar.

Genus 53. Ganymedes Huxley 1910:155. Associative, epimerite not known. Complete fusion of two individuals into one cytoplasmic mass. Cup at posterior end to aid in attachment. Spores unknown. Liver of crustaceans.

Genus 54. Agrippina Strickland 1912:108. Sporonts solitary, epimerite a circular disc armed with digitiform processes on periphery, short neck. Spores ellipsoidal.

POLYCYSTID GREGARINES IN THE DIPLOPODA*

NAME OF PARASITE	NAME OF HOST
Stenophora larvata (Leidy) Ellis	*Spirobolus spinigerus* Wood
Stenophora polydesmi (Lankester) Watson	*Fontaria virginensis* (Drury)
Stenophora julipusilli (Labbé) Crawley	*Julus* and *Parajulus*
Stenophora juli (Frantzius) Labbé	*Julus sabulosus* (L.)
	Julus boleti C. Koch
Stenophora dauphinia Watson	*Julus mediterraneus* Latzel
	Julus boleti C. Koch
	Julus fallax Meinert
Stenophora spiroboli Crawley	*Spirobolus* sp.
Stenophora fontaria (Crawley) Watson	*Fontaria* sp.
	Polydesmus sp.
Stenophora brölemanni Léger and Duboscq	*Blaniulus hirsutus* Bröl.
	Brachydesmus superus Latzel
	Brachyiulus pusillus lusitanus Verh.
Stenophora nematoides Léger and Duboscq	*Strongylosoma italicum* Latz.
Stenophora varians Léger and Duboscq	*Schizophyllum corsicum* Bröl.
Stenophora producta Léger and Duboscq	*Julus varius* Fabricus
Stenophora aculeata Léger and Duboscq	*Craspedosoma rawlinsii simile* Verh.
Stenophora polyxeni Léger and Duboscq	*Polyxenus lagurus* (L.) Lat.
Stenophora silene Léger and Duboscq	*Lysiopetalum foetidissimum* Savi
Stenophora chordeume Léger and Duboscq	*Chordeuma silvestre* C. Koch
Stenophora corsica Léger and Duboscq	*Craspedosoma légeri* Bröl.
Stenophora robusta Ellis	*Parajulus venustus* Wood
	Orthomorpha gracilis (C. Koch)
	Orthomorpha sp.

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*The parasites are arranged in chronological order, under each genus.

Stenophora cockerellae Ellis	*Parajulus* sp.
Stenophora elongata Ellis	*Orthomorpha coarctata* (Sauss.)
Stenophora impressa Watson	*Parajulus impressus* (Say)
Stenophora lactaria Watson	*Callipus lactarius* (Say)
Stenophora diplocorpa Watson	*Euryurus erythropygus* (Brandt)
Cnemidospora lutea Schneider	*Glomeris* sp.
Amphoroides polydesmi (Léger) Labbé	*Polydesmus complanatus* (L.) *Polydesmus dispar* Silvestri
Amphoroides calverti (Crawley) Watson	*Callipus lactarius* (Say)

STENOPHORA LARVATA (Leidy) Ellis

[Figure 1]

1849	*Gregarina larvata*	Leidy	1849 :232
1851	*Gregarina larvata*	Diesing	1851 :553
1853	*Gregarina juli marginati*	Leidy	1853 :237
1863	*Gregarina juli*	Lankester	1863 :94
1875	*Stenocephalus juli*	Schneider	1875 :584-5
1899	*Stenophora juli*	Labbé	1899 :15
1903	*Stenophora juli*	Crawley	1903 :51
1904	*Stenophora iulimarginati*	Léger and Duboscq	1904 :362
1913	*Stenophora larvata*	Ellis	1913a :286

Stenophora: Sporonts solitary, elongate. Maximum length 800μ, maximum width 23μ. Ratio length protomerite : total length :: 1 : 20; width protomerite : width deutomerite :: 1 : 2. Protomerite small, subglobular, slightly flattened top and bottom, a flat circular papilla at apex with an apparent pore in center. A conspicuous constriction at septum. Deutomerite elongate-cylindrical, tapering gradually from center to an acute but bluntly pointed cone. Endocyte of protomerite clear, granular; of deutomerite dense and opaque. Nucleus small, spherical.

Taken at Philadelphia, Pa. Host: *Spirobolus spinigerus* Wood (*Julus marginatus* Say). Habitat: Intestine.

This species was observed by Leidy in 1849 and was the first gregarine he observed. His general statement regarding the parasite is quoted here nearly in full on account of its quaintness.

> "Gregarina is probably the larva condition of some more perfect animal, but in the 116 individuals of Julus which I have examined, I have not been able to detect any form which could be derivable from it. Creplin doubts its animality. . . . I detected movements of an animal character, and this led me to seek for muscular structure, which resulted in the discovery of the longitudinal lines of the inferior cell. These escaped the observation of Siebold . . . In the state in which Gregarina is found, it would probably hold a rank between the Trematoda and Trichina, the lowest of the Nematoidea."

To Leidy, then, must be attributed the discovery of the longitudinal striations in the epicyte and it is interesting to note that he discovered them during his first observations on the gregarines.

Leidy renamed the species four years later from the host in which it was found.

Lankester (1863:94), in a classification of the gregarines, grouped three of Leidy's forms: *G. larvata, G. juli marginati,* and *G. juli pusilli,* together with *Gregarina juli* Frantz. under the name of the latter, apparently because they were all parasites and the only known parasites of the same diplopod.

Schneider (1875:585) disregarding the rule of priority united *Gregarina juli marginati* and a species which he discovered under the name *Stenocephalus juli* (Leidy). His remarks are as follows:

> "Cette espèce est commune et me paraît être identique à celle décrite par Leidy sous le nom de *Gregarina juli marginati.* Dans ce cas elle serait probablement répandue chez les différentes espèces du genre Julus, puisqui'on la connâitrait déjà chez trois d'entre elles. . . . L'espèce est légèrment polymorphe elle est tantôt très-allongée et relativement étroite, tantôt remarquablement massive; mais son protomérite demeure toujours identique à lui-même et suffit amplement au diagnostic."

Leidy gave no measurements of his species and Schneider based the identity of the two forms on the similarity of Leidy's figures with his material . It is true that in general shape the two are very similar but the protomerites differ slightly and the color differs markedly. Leidy's species is white; Schneider's yellow to yellow-orange. Because of these dissimilarities, the two forms should be separated.

Labbé (1899:15) changed the name of the genus *Stenocephalus* of Schneider to *Stenophora.*

Crawley (1903a; 634) did not consider the two species identical. His words are as follows:

> "There is a good deal of confusion regarding the gregarines occurring in the Diplopod family Julidae. These gregarines all bear a certain amount of resemblance to one another, and it has been usual to relegate all of them to the species *Stenophora juli* Frantz. Léger and Duboscq (1903) have recently shown that such a procedure is not warranted for the fauna of Corsica and the case is certainly the same for that of the eastern United States. The Julidae of this region are infected with certainly two and possibly three species of Stenophora, while the classic *S. juli* apparently does not occur."

Léger and Duboscq (1904:361-2) take up the same discussion in their history of the Stenophoridae as follows:

> "Leidy fit connâitre une Grégarine assez particulière, parasite de l'intestin de *Iulus marginatus* Say. Il l'appela d'abord (1851) *Gregarina larvata,* puis changea son nom en celui de *Gregarina iuli marginati* dans un travail postérieur (1853) ou il décrit une autre Grégarine, *G. iuli pusilli,* parasite d'un petit iule . . . qui n'est pas *Iulus pusillus* Leach.

Ray Lankester (1863) réunit les deux Grégarines de Leidy au *Stenophora iuli* de Frantzius, et cette synonymie fut admise par tous les auteurs qui suivirent.

Schneider (1875) le premier, décrivit avec précision la Grégarine parasite des *Iulus sabulosus* et *Iulus terrestris.* Il nota l'absence d'épimérite, la striation de l'épicyte trés marquée sur les 2 segments, la coloration jaune ou orangée de l'entocyte et le caractère des spores. Ces particularitès lui firent crèer le genre Stenocephalus pour cette Grégarine qu'il identifia à la Grégarine décrite par Leidy dans *Spirobolus marginatus* Say. Il l'appela *Stenocephalus iuli* Leidy, nonobstant les règles de la nomenclature.

Stenocephalus iuli devint ainsi la seule Grégarine des Iules et Gabriel (1880) y rapporta de lui-même sa *Gregarina paradoxa.*

Dans les Sporozoa du Tierreich (1899) Labbé consacra les habitudes prises en ne reconnaissant pour Grégarine parasite des Iules que le *Stenophora iuli.* Il se contenda de remplacer le nom générique de Schneider par celui de Stenophora, le nom de Stenocephalus ayant été attribué antérieurement à un genre d'Hémiptères.

Howard Crawley (1903) étudiant les Grégarines des Iules et Paraiulus des Etats-Unis, rapporta les diverses espèces de Leidy au *Stenophora iuli,* tout en créant une nouvelle espèce pour un Stenophora d'un Spirobolus. Mais, dans un travail sue la faune de Corse (1903) nous avons montré que les Stenophora étaient representés par plusieurs espèces reconnaissables à la seule vue de céphalin. Notre facon de voir est adoptée par Crawley dans un second travail (1903a) et il restaure le *Stenophora iulipusilli* Leidy en soutenant que que le classique *Stenophora iuli* n'existe pas en Amerique.

Les espèces américaines de Stenophora se trouvent ainsi bien séparées du *Stenophora iuli* (Frantzius) Schneider. Nous (1903a) en avons détaché également un certain nombre de Stenophora des Diplopodes de Corse ou de Provence."

Stenophora larvata has not been found since Leidy's discovery of the species and its validity must be questioned until his work is substantiated by rediscovery of this parasite.

STENOPHORA POLYDESMI (Lankester) Watson

[Figures 2, 3, 4]

1853	*Gregarina polydesmi virginiensis*	Leidy	1853 :238
1863	*Gregarina polydesmi*	Lankester	1863 :94
1899	*Amphoroides polydesmi*	Labbe	1899 :20
1903	*Gregarina polydesmivirginiensis*	Crawley	1903 :45-46
1913	*Amphoroides polydesmivirginiensis*	Ellis	1913b :274
1916	*Stenophora polydesmi*	Watson	(This paper)

Stenophora: Sporonts solitary, elongate. Length 400-900μ*; width of deutomerite through widest part 25 to 60μ. Ratio length protomerite : total length :: 1:: 15 to 1 : 17; width protomerite : width deutomerite :: 1: 1.5 to 1 : 2 in normally extended individuals. Protomerite subglobular to elongate, length twice the width. Slight constriction, if any, at septum. Protomerite as wide or wider than deutomerite at the septum. Deutomerite cylindrical, well rounded at posterior end. Endocyte tranluscent. Nucleus visible in vivo, ellipsoidal, one spherical karyosome.

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*Crawley (1903:46) gives 400μ as a maximum while Leidy gives 900μ.

Cyst and spores unknown.

Taken at Philadelphia and Wyncote, Pa., and Raleigh, N. C. Host: *Fontaria virginiensis* (Drury) *(Polydesmus virginiensis).* Habitat: Intestine.

This species was described by Leidy (1863:238).

Léger (1892:132) described a species, *Amphorella polydesmi,* from the intestine of *Polydesmus complanatus* (L.). He created for the species a new genus, characterized by the presence of a short circular cup-like protomerite.

Labbé (1899:20) united the *A. polydesmi* of Léger and *G. polydesmi virginiensis* of Leidy as one species and because Amphorella was invalid, called the genus Amphoroides and the species *Amphoroides polydesmi* (Léger).

But the protomerite of *G. polydesmi virginiensis* does not coincide in shape with that of the genus Amphoroides, for it is subglobose and bears no indication of a cup-like depression which is characteristic of the latter genus; therefore it must be placed elsewhere. The three following factors coincide with those of the genus Stenophora, viz: a) subglobose protomerite, b) relative length of protomerite as compared with total length, c) solitary sporonts. The spores and the epimerite still remain undiscovered and until they are found the generic determination is, of course, not absolute.

Crawley (1903:45-6) called the species *G. polydesmivirginiensis* (Leidy), but in a later paper (1903a:640) he included it in a group of doubtful forms, all of which, however, he placed in the genus Gregarina.

Ellis (1913b:274) erroneously attributes to Crawley the assignment of the species name *Amphoroides polydesmivirginiensis.* It is Ellis himself at this point who names the species *A. polydesmivirginiensis* (Leidy). He offers no explanation therefor.

For the reasons given above, the species is now removed from the genus Amphoroides and placed in the genus Stenophora, the name now standing *Stenophora polydesmi* (Lankester) Watson. The trinomial of Leidy was shortened to a binomial by Lankester and this binominal must stand.

This is a well defined species, having been found and drawn by Crawley in 1903 and taken from the host in which it was originally found. The writer has examined a half dozen specimens of this diplopod taken at Urbana, without finding an instance of infection.

STENOPHORA JULIPUSILLI (Labbé) Crawley

[Figure 6]

1853	*Gregarina juli pusilli*	Leidy	1853 :238
1863	*Gregarina juli*	Lankester	1863 :94
1899	*Gregarina julipusilli*	Labbé	1899 :35
1903	*Stenophora julipusilli*	Crawley	1903a :634-5
1904	*Stenophora iulipusilli*	**Léger and Duboscq**	1904 :362

Stenophora: Sporonts solitary, elongate, rather stout. Maximum length 400μ, maximum width not given. Ratio length protomerite : total length :: 1 : 9 in adults; ratio width protomerite : width deutomerite :: 1 : 1.5. Shape protomerite conical with a rather sharp apex, widest below median portion, papilla with an apparent pore at anterior end, deep constriction at septum. Slightly broader than high. Deutomerite irregularly cylindrical, four times as long as broad, sometimes widest through middle, sometimes posterior to middle. Endocyte very dense in adults. Granules of protomerite different from those of protomerite. Nucleus spherical and large, attaining half the width of deutomerite. Contains a large karyosome. Cyst and spores unknown.

Taken at Philadelphia, Pa. Hosts *Julus* sp. and *Parajulus* sp. Habitat: Intestine.

This parasite was found and described by Leidy as *Gregarina julipusilli.* Both figures he gives appear to be those of immature specimens (see Fig. 5). From Leidy's data alone, I should consider the species invalid.

Crawley (1903 :51) includes both *G. juli pusilli* and *G. juli marginati* with the classic *Stenophora juli* Frantzius under the name of the latter. That this determination was erroneous Crawley later discovered and (1903a :634-5) he separated the three species:

> "This species is easily separated from *S. juli* by the size of the protomerite. In *S. juli* the length of the protomerite, according to the figures given by Schneider (1875) makes up only about 6% of the total length. In *S. julipusilli* this proportion increases to 10% in the adults and 15% in the young."

Stenophora julimarginati therefore stands as a separate, well defined species; the species described as *Gregarina juli pusilli* Leidy was renamed by Crawley as *Stenophora julipusilli* (Leidy). Crawley's words concerning the confusion of names are as follows:

> "There is a good deal of confusion regarding the gregarines occurring in the Diplopod family Julidae. These gregarines all bear a certain amount of

> resemblance to one another, and it has been usual to relegate them all to the species *Stenophora juli* Frantzius. . . . The Julidae of this region are infected with certainly two and possibly three species of Stenophora, while the classic *S. juli* apparently does not occur. Of these species, one is unquestionably the form described by Leidy (1853) as *Gregarina julipusilli.* As indicated by the specific name, Leidy considered its host to be *Julus pusillus* Say. According to Bollman (1887) this milliped, correctly *Julus minutus* Brandt does not occur in Pennsylvania, and it may be that Leidy was mistaken in his identification. This matter is not, however, of any great importance, and the specific name of the gregarine must stand. Leidy spelled the specific name of the host *pusullus,* whereas Say's memoir (1821) renders it *pusillus,* which spelling will be used for the name of the gregarine."

Leidy's original spelling of the host name (1853 :238) *pusillus* is the correct one and the last remark of Crawley is uncalled for. The correct name of the diplopod, according to Bollman (1893), is now *Nemasoma minutum* (Brandt).

Since Leidy's description and figures are so inadequate and even his determination of the host possibly in error, there was no valid reason for Crawley's having retained the specific name *julipusilli* when he redescribed the species (1903a: 634-5).

Léger and Duboscq in the citation just given mention (1904) *S. iulipusilli* (Leidy) Crawley as a distinct species (note the last quotation).

In the specific diagnosis, given at the beginning of this species, Leidy's description was excluded. It is as follows:

> "*Gregarina Juli pusilli.* White, translucent, oval. Cephalic sac hexahedral, with the sides rounded or forming a double cone, base to base, with the upper apex subacute or truncated in younger individuals. Posterior sac robust, oval; granular contents, fine, translucent; interior corpuscle, globular, transparent; nucleus transparent, without nucleolus. Whole length from 1 1500 in. to 1 275 in. Breadth of largest 1 500 in. Diameter of head of largest 1 1500 in. Hab. Intestine *Julus pusillus.*"

The name of this species must be a binominal and since Labbé was the first to give such a name to the particular species here designated, the species name becomes *Stenophora julipusilli* (Labbé) Crawley.

STENOPHORA JULI (Frantzius) Labbé

[Figures 7 and 8]

1848	*Sporadina Juli*	Frantzius	1848 :195
1851	*Gregarina juli*	Diesing	1851 :15
1863	*Gregarina juli*	Lankester	1863 :94
1875	*Stenocephalus juli*	Schneider	1875 :584-5
1880	*Gregarina paradoxa*	Gabriel	1880 :371
1899	*Stenophora juli*	Labbé	1899 :15
1903	*Stenophora juli*	Crawley	1903 :51
1904	*Stenophora iuli*	Léger and Duboscq	1904 :363-8

Stenophora: Sporonts solitary, elongate. Dimensions not given. Ratio length protomerite : total length :: 1 : 20 (approximately); ratio width protomerite : width deutomerite :: 1 : 2. Protomerite small, cylindrical at base, sharply conical above, little wider than high, a small papilla with an apparent pore at apex. Deutomerite elongate, slightly wider in anterior third than elsewhere, tapering gradually to an acute but blunt cone. Endocyte yellow to orange. Nucleus spherical, diameter half that of the deutomerite at its widest part, containing one large karyosome. Cysts dehisce by simple rupture. Spores fusiform with equatorial line.

Taken at Roscoff, France. Hosts: *Julus sabulosus* (L.); *Julus fallax* Meinert *(Julus terrestris)*. Habitat: Intestine.

Stenophora juli has been the source of more confusion and of greater discussion than any other gregarine parasitic in the diplopods. The too concise descriptions and the lack of any measurements of the animals by the earlier writers have led later workers to place a number of different parasites in this same group and to regard them all as *Stenophora juli.*

Frantzius' beautiful drawings are accompanied by no description beyond the statement that the parasite was found in Julus.

Diesing called the parasite *Gregarina juli* Frantzius. His description is as follows:

> "Proboscis? Receptaculus capitellatum acutum brevissimum. Corpus longum fusiforme. Hab. *Julus terrestris* . . ."

Lankester (1863 :94) relegated to this species the following: *Gregarina juli pusilli* Leidy, *G. juli marginati* Leidy, and *G. larvata* Leidy, all of which belong elsewhere, the last two being synonymous.

Schneider (1875:584-5) described a species as *Stenocephalus juli* from the intestine of *Julus sabulosus* and what he regarded as *Julus terrestris**. He considered his species as related if not synonymous with a species described by Leidy in 1853 as *Gregarina juli marginati.* His words are these:

> "Cette espèce est commune et me parâit être identique à celle décrite par Leidy sous le nom de *Gregarina juli marginati.* Dans ce cas, elle serait probablement répandue chez les différentes espèces du genre Julus, puisqu'on la connâitrait déjà chez trois d'entre elles . . . L'espèce est légèrment polymorphe; elle est tantôt très-allongée et relativement étroite, tantôt remarquablement massive; mais son protomérite demeure toujours identique à lui-même et scuffit amplement au diagnostic."

Schneider overlooked the color factor in correlating the two species. Leidy described his *G. juli marginati* as ''opaque, white.'' Schneider's *Stenocephalus juli* has the endocyte colored yellow or orange. Schneider gives no dimensions, but from the figure the proportions of his species agree perfectly with those of Leidy's species. The protomerites of the two species are slightly different in shape in the character of the papilla at the apex. The papilla in Leidy's species is large and flattened and the apparent pore is widest at the apex, narrowing as it approaches the endocyte; in Schneider's figure the papilla is smaller, more conical, either sharp or blunt at the end, slender in the middle, broadening at the base next the endocyte.

While the two species are obviously closely related, I am of the opinion that they are not identical. Crawley (1903a:634) says ''the classic *Stenophora juli* apparently does not occur'' in the United States and to date, 1915, it has not been described from this country.

If Schneider had given a set of dimensions for his species, that were identical with those of Leidy, the personal equation might have been considered to such an extent as to eliminate the color consideration and the variation in the two protomerites.

Leidy's *Gregarina julu marginati* is thus seen to be distinct from Schneider's *S. juli* and stands today as *Stenophora larvata* (Leidy) Ellis.

In 1880, Gabriel (p. 371) mentioned a species which he calls *Gregarina paradoxa* and says it is identical with *G. juli* (Frantz.) Schn. Neither description nor drawings accompany this statement and the reason for giving the species a new name, if it be *S. juli,* is not apparent.

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*Léger and Duboscq (1904:364) say that *J. fallax* Mein. (*J. albipes* C. Koch) is probably the *J. terrestris* of Schneider.

Labbé (1899:15) unites under the name *S. juli* (Frantz.) Schn. all of the following:

1848 *Gregarina juli* Frantzius
1875 *Stenocephalus juli* Schneider
1851 *Gregarina larvata* Leidy
1853 *Gregarina juli marginati* Leidy
1880 *Gregarina paradoxa* Gabriel

Why Labbé regards them all as synonymous, he does not state. They appear to be alike only in that they are all parasites of the same diplopod, Julus. With the exclusion of the last three*, the species stands as containing the original *G. juli* Frantz. and *Stenocephalus juli* Schn. The ratios obtained from figures given by Frantzius and Schneider are almost identical. Neither author gives any dimensions, so the animals may agree not at all in actual size. The character of the endoplasm, its granular content and color, may differ considerably.

Léger and Duboscq give a detailed account of the various species which have been confused in the literature. For the entire quotation, see under the heading *Stenophora larvata* (Leidy) Ellis.

From a lack of positive evidence to the contrary, the two species *Gregarina juli* Frantz. and *Stenocephalus juli* Schn. stand as a single species, now called *Stenophora juli* (Frantzius) Schneider.

Léger and Duboscq (1904:363-8) described a parasite as *Stenophora juli* and considered it synonymous with the *S. juli* above. The animal which they described differs greatly from the classic *S. juli* in shape of all its parts, in its proportions, the density of its endoplasm, and in the shape of its nucleus (!). A detailed consideration of these factors is taken up under *Stenophora dauphinia.*

STENOPHORA DAUPHINIA Watson

[Figure 9]

1904	*Stenophora juli*	Léger and Duboscq	1904:363-8
1916	*Stenophora dauphinia*	Watson	(This paper)

Stenophora: Sporonts solitary, elongate. Total length 250 to 300μ. Width 19μ. Ratio length protomerite : total length :: 1 :10; width protomerite :: 1 : 0.9. Protomerite dilated in posterior two-thirds, separated from anterior part by a deep circular constriction. Apex broadly conical, papillate anterior end, with an apparent pore. Deutomerite cylindrical, attaining ten times the length of the protomerite.

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*The third and fourth are synonymous being now *S. larvata;* the fifth is synonymous with *S. juli.*

Width nearly the same throughout and ending in a blunt rounded posterior extremity. Endocyte not described. Nucleus ellipsoidal, 1.7 times as long as wide. Cysts spherical, 250μ in diameter. Spores regularly ovoidal, epispore present. Equatorial line on spores.

Taken at Turin, Italy, and in Dauphine, France. Hosts: *Julus mediterraneus* Latzel *(Schizophyllum mediterraneum* Latz.) ; *Julus boleti* C. Koch *(Julus londinensis* Mein.) ; *Julus fallax* Mein. *(Julus albipes* C. Koch).

The authors described a parasite found in the same host as that upon which Schneider based his observations in his discovery of *Gregarina juli* (Frantzius). The species named by Schneider as the host of his parasites was *Julus terrestris* (Linnaeus) Porat but Léger and Duboscq observed that this species does not occur in France (1904:363).

> "Nous décrirons d'abord *Stenophora iuli* (Frantzius) Schneider, qui nous a fourni de bons documents pour l'étude du développement des Stenophorides, et dont il importe de préciser la diagnose. Nous entendons par *Stenophora iuli* (Frantz.) Schneider le parasite de *Schizophyllum sabulosum* L. qui correspond à la description de Schneider. Cet auteur trouvait aussi *Stenophora iuli* dans *Iulus terrestris,* mais *Iulus terrestris* L. n'est pas une détermination. Depuis un siècle, les anastomistes appellent de ce nom tous les Iules qui sont de coleur noire, et le véritable *Iulus terrestris* (Linné) Porat ne parait pas exister en France. . . Et en effet, nous voyons dans un certain nombre d'Iules, une Grégarine bien voisine du parasite de *Schizophyllum sabulosum* L. Citons notamment parmi les hôtes de *Stenophora iuli, Schizophyllum mediterraneum* Latz. de la Tourraine, *Iulus londinensis* Mein. de la Tourraine, *Iulus albipes* C. K. du Dauphiné."

These authors base their observations on the parasites found chiefly in *Julus albipes.* In *Julus sabulosus* the gregarine attains a length of 450μ; in *J. fallax* Mein. and *J. boleti* C. K. of 300μ. Besides the elongate form, they mention a globular form nearly as wide as long, and reaching 130μ in length. They do not illustrate this form. The elongate sporont, only, is figured. The authors do not describe the shape of the various parts and make no comparison of their form with the classic *S. juli,* basing their identification rather on a similarity of hosts than of parasites.

The data and figures given by Léger and Duboscq (1904) and by Schneider (1875) compare as follows:

	SCHNEIDER	LÉGER AND DUBOSCQ
Total length	....	450 max.
Total width	....	....
Ratio l. prot : total l	1 : 20	1 : 10
Ratio w. prot : w. deut	1 : 2	1 : 0.9
Shape protomerite	Apex papillate, with pseudo-canal, lower part cylindrical, upper part broadly conical, no constriction in protomerite.	Apex papillate with pseudo-canal, lower part broader than upper and separated from above by a deep circular constriction. Deep constriction at septum.
Shape deutomerite	Irregularly cylindrical, tapering from anterior third to a sharp but rather broad cone. Twice as wide at shoulder as at protomerite.	Regularly cylindrical, of approximately same width throughout, tapering slightly at posterior tip. Slightly narrower than protomerite.
Nucleus	Spherical. One large karyosome.	Ellipsoidal (1 : 1.7) with one large karyosome.
Shading in figure	Protomerite Dark Deutomerite Dark	Very light Dark

The proportions of the body dimensions, the shape of the two protomerites, and the shape of the two nuclei indicate at a glance that more than one species is under consideration and the species described by Léger and Duboscq should be renamed. I therefore designate it *Stenophora dauphinia.*

STENOPHORA SPIROBOLI Crawley

[Figure 10]

1903	*Stenophora spiroboli*	Crawley	1903:51
1903	*Cnemidospora spiroboli*	Crawley	1903a:638
1913	*Stenophora spiroboli*	Ellis	1913b:286

Stenophora: Sporonts solitary, elongate. Maximum length 1000μ; width not given. Ratio length protomerite : total length :: 1 : 32; width protomerite : width deutomerite :: 1 : 1.5. Protomerite small, rounded at anterior end, one-third as high as wide. Septum concave upward, thus forming a protomerite in the shape of a double convex lens. No constriction at septum; perfectly smooth contour throughout, from end to end. Deutomerite elongate cylindrical, broadest just below septum where it attains one and a fourth times the maximum width of the protomerite. Slighly wider in anterior third than elsewhere, tapering slightly and terminating bluntly. Endocyte opaque in both protomerite and deutomerite. Nucleus undescribed, not visible in vivo. Cysts spherical, 350 to 500μ in diameter with thick epicyst. Dehiscence by rupture, spores fusiform, 12.5 by 7.5μ.

Taken at Raleigh, N. C. Host *Spirobolus* sp. Habitat: Intestine (?).

Crawley first described this species as *Stenophora spiroboli,* transferring it later to the genus Cnemidospora when the cyst and spores had been examined, probably because of the character of the spore-integument. The genus Cnemidospora Schn. (1882:446-7) is diagnosed thus:

> Protomerite subglobular, divided into two parts, the upper greenish gray, the lower yellow to brown; deutomerite elongate, cylindrical, spores ellipsoidal (nearly spherical) with a thick integument. No spore ducts in cyst.

The species in question does not coincide with the characters of the genus Cnemidospora. Neither the coloration of the protomerite nor the shape of the spores fits the generic description.

Ellis has replaced the species in the originally assigned genus, where it undoubtedly belongs because of the form and coloration of the sporonts, the character of the cyst dehiscence, and the shape of the spores.

STENOPHORA FONTARIA (Crawley) Watson

[Figures 11 and 12]

1903	*Amphoroides fontariae*	Crawley	1913:53
1913	*Amphoroides fontariae*	Ellis	1913b:274
1916	*Stenophora fontaria*	Watson	(This paper)

Stenophora: Sporonts solitary, ovoidal. Maximum length 135μ; width not given. Ratio length protomerite : total length :: 1 :4 to 1 : 5.5; width protomerite : width deutomerite :: 1: 1.5 to 1 : 2. Protomerite subglobose, widest in posterior two thirds, tapering to a blunt cone. Deep constriction at septum. Deutomerite elongate ovoidal, terminating bluntly. Endocyte nearly transparent in protomerite, very opaque in deutomerite. Nucleus not always visible in vivo, small, spherical, with one karyosome. Cyst and spores unknown.

Taken at Wyncote, Pa., Raleigh, N. C., and at East Falls Church, Va. Hosts: *Polydesmus* sp. and *Fontaria* sp. Habitat: Intestine.

Léger (1892) created the genus Amphorella, afterwards renamed Amphoroides by Labbé (1899:20), to include species with solitary ovoidal sporonts having a protomerite short, compressed and crateriform, and spores rhombus-shaped (seen in one plane) and biconical, with but one integument.

Léger and Duboscq (1904:375) compared one of their new species with the species in question. Their remarks are:

> "*Stenophora chordeume* nous parâit, par sa forme, une espèce très voisine de la Grégarine des Polydesmus et Fontaria des Etats-Unis, signalée par Crawley (1903) sous le nom d' *Amphoroides fontariae.* Les figures qu'en donne cet auteur dans sa Pl. I fig. 12, 13, 14 nous portent à croire, d'après les caractères de l'épimérite, qu'il s'agit plutôt d'un Stenophora que d'un Amphoroides. Il est d'ailleurs impossible de se prononcer avec certitude sur ce point, car Crawley ne nous fait pas connaitre les sporocystes de sa Grégarine, et on sait que, outre la forme de l'épimérite, celle des sporocystes distingue nettement les Amphoroides des Stenophora; dans Amphoroides, ils sont biconiques; chez Stenophora, ils sont ovoides."

Thus the basis for the original inclusion of the species in the genus Amphoroides is not that of spore characteristics and until the spores are known the generic position of the species will not be absolute. The shape of the protomerite of the species under consideration is, however, very unlike that of the type species of this genus, *A. polydesmi* Léger, and hence the species cannot consistently be left in this genus. Its logical position seems to be with the Stenophoridae because of elimination from any other genus rather than from any positive character, and I should designate it *Stenophora fontaria* (Crawley).

STENOPHORA BRÖLEMANNI Léger and Duboscq

[Figure 13]

1903 *Stenophora brölemanni* Léger and Duboscq 1903a:339-40

Stenophora: This gregarine is small, from 40 to 54μ long and is compressed laterally, especially in the anterior part. It lives within the cell of the host during the greater part of its life cycle. The older intercellular individuals are subspherical and occupy a cavity larger than that occupied by the younger ones, which is formed by the greater destruction and compression of surrounding cells. The protomerite is invaginated into the anterior end of the deutomerite like a cork into the neck of a bottle. When the animal leaves the epithelium, the protomerite still retains its invaginated position. The protomerite in profile is cylindrical, rather flattened at the top, and when seen from the front it is as broad as high, widest anterior to the middle and possesses at the summit a small plate slightly concave upward and bearing in the center a small spherical papilla. Léger and Duboscq say this papilla may correspond to a protractile epimerite, for fibrillae seem to radiate from the apex outward over the anterior third of the protomerite. The deutomerite seen in profile is much larger at its posterior end than elsewhere, i. e., the animal is compressed chiefly in the anterior half. A front view shows a deutomerite as broad as it is high. The nucleus is large, spherical or slightly ovoidal and contains one large karyosome. The parasite is characterized then by its compression, the invagination of its protomerite and by its inter- or intra-cellular location (the authors are not sure which).

Taken in Provence, France, and on the island of Corsica. Hosts: *Blaniulus hirsutus* Bröl., *Brachyiulus superus* Latzel, *Brachyiulus pusillus lusitanus* Verh. Habitat: Intestine.

STENOPHORA NEMATOIDES Léger and Duboscq

[Figures 14 and 15]

1903 *Stenophora nematoides* Léger and Duboscq 1903a:335-7

Stenophora: Sporonts solitary, elongate. Average length 170μ, maximum length 300μ. Width not given. Ratio length protomerite : total length :: 1 : 10; width protomerite : width deutomerite :: 1 : 3. Protomerite cylindrical, slighly dilated a little anterior to septum. Twice as long as wide, dome shaped at apex; constriction at septum. Deutomerite normally with constriction at end of anterior third, or half; above this point considerably dilated, especially in posterior portion. Posterior half or two thirds of deutomerite, i. e., part below constriction, cylindrical, ending in a broadly rounded or somewhat truncate extremity. The largest sporonts without the peculiar dilated portion of the deutomerite; nematoid in shape, long, slender, cylindrical, often slightly curved and with a body as much as seventeen times as long as to protomerite (170 : 10), and not more than 7μ wide throughout. Endocyte granules fine, homogeneous except in anterior end of protomerite where deeply staining chromatic granules are accumulated. Nucleus large and ovoidal, the long axis parallel to the long axis of the body. One large karyosome. Epimerite a large subglobular hyaline body. Cyst and spores unknown.

Taken at Bastia, Corsica. Host: *Strongylosomum italicum* Latzel. Habitat: Intestine.

The authors' conclusion concerning this species is as follows:

> "Bien que nous ne connaissions pas l'évolution complète de cette Grégarine, nous avons la conviction qu'il s'agit d'une espèce voisine du *Stenophora iuli,* car à part la forme générale nématoide qui est ici très caractèristique de l'espèce, toutes le autres particularitiés structurales (forme du protomérite, caractère du noyeau, présence de grains chromatoides accumulés surtout dans le protomérite, etc.) se retrouvent aussi chez les autres espèces du genre Stenophora, lequel d'ailleurs est spécial aux Diplopodes."

STENOPHORA VARIANS Léger and Duboscq

[Figures 16 and 17]

1903 *Stenophora varians* Léger and Duboscq 1903a :337-9

Stenophora: Sporonts solitary, dimorphic, elongate and globular. The elongate forms cylindrical or slightly compressed, slightly attenuate at both extremities, attaining a maximum length of 250μ. Width not stated. Ratio length protomerite : total length :: 1 : 6 to 1 : 7; ratio width protomerite : width deutomerite :: 1 : 1. Protomerite cylindro-conical, 1½ times as long as wide, its summit depressed, with an apparent pore. Constriction at septum. Deutomerite just below septum a little narrower than protomerite a short distance above. Deutomerite irregularly cylindrical, slightly curved in adults, truncate or broadly rounded behind. Nucleus spherical with a large karyosome. Endocyte of protomerite consisting of large deeply staining bodies, of deutomerite large non-staining bodies with a few scattered chromatic bodies.

The globular sporonts more rare than the elongate ones but coexisting with the latter. Maximum length 35 to 40μ. Deutomerite large, globular protomerite, cylindro-conical and shorter than in the elongate forms. A small papilla at anterior end. Protomerite shows same staining reaction as elongate forms and the nucleus is relatively larger, with a much larger karyosome.

Taken at Ajaccio, Corsica. Host: *Schizophyllum corsicum* Bröl. Habitat: Intestine.

Relative to the dimorphism, the authors make these remarks:

> "Au sujet de interprétation de ces deux formes de Stenophora dans un même hôte, on peut émettre plusieurs hypothèses: On bien la forme globuleuse, on raison de sa petite taille représente un stade très jeune de la Grégarine; ou elle représente une espèce distincte de la forme allongée; ou bien enfin il s'agit d'un dimorphisme sexuel dans des individus d'une seule et même espèce. Nous nous rattachons d'autant plus volontiers à cette dernière hypothèse que l'on observe assez souvent de jeunes formes allongées de volume bien inférieur à celui des formes globuleuses."

The great difference in maximum lengths recorded of the elongate (250μ) and the globular (40μ) forms of this species would hardly indicate that the latter is mature. The immature specimens of most species of gregarines are more or less globular, stain deeper, have a protomerite which changes but little in shape as maturity approaches, and possess nuclei much larger in proportion than the adults, and often of a different shape from that of the adults. I have often seen these globular individuals as large or a little larger than other individuals which had already assumed their adult form, and have attributed the difference to a difference merely in the amount of nourishment they have received. I think if we are to assume that there is a sexual dimorphism, we must look for two individuals of somewhere nearly the same size rather than one six times the size of the other.

While sexual dimorphism is a factor to be looked for among gregarines, it has never been definitely proven for a single species. There may be a difference in sexes among the sporonts, but if so, this difference seems to be of a chemical nature or of such slight morphological significance as to have been generally overlooked; and it should be evident among all or most of the members of the same family rather than confined to a few species only.

STENOPHORA PRODUCTA Léger and Duboscq

[Figure 18]

1903	*Stenophora iuli*	Léger and Duboscq 1903a:315
1904	*Stenophora producta*	Léger and Duboscq 1904:375-7

Stenophora: Sporonts solitary, very elongate. Sporonts 1000μ long, width not given. Ratio length protomerite : total length :: 1 : 20; ratio width protermite : width deutomerite :: 1 : 21. Protomerite globular, slightly flattened top and bottom, sometimes slightly invaginated at the deutomerite. At apex a small papilla with an apparent pore. Deutomerite very long, cylindrical, broadly rounded behind. Endocyte of protomerite finely granular, staining deeper than the deutomerite. The nucleus ellipsoidal, with one large karyosome. An inverted xiphoid cone rounded at the summit, projecting from the septum downward into the deutomerite and consisting of homogeneous protoplasm staining deeper than that of the deutomerite. Probably consisting of nutriment manufactured by the protomerite and filtered through the septum, to be eventually diffused through the deutomerite. Epimerite a small knob. Cysts spherical, size not given. Spores ovoidal, 5μ long.

Taken at Corte, Corsica. Host: *Julus varius* Fabricus *(Parajulus varius* Fab.). Habitat: Intestine.

The reason for the confusion of names mentioned above appears in the following quotation from Léger and Duboscq (1904:375):

> "Nous avons déjà signalé la présence de cette Grégarine dans l'intestin de *Pachyiulus varius* Fab. de la Corse (1903) et nous l'avons tout d'abord confondue avec *Stenophora iuli,* ne l'ayant observée a cette époque que sûr le vivant. Depuis une étude plus approfondie sur des préparations colorées nous a convaincu qu'il s'agit d'une espècee morphologiquement différente de *Stenophora iuli* (Frantzius)

Schneider et nous la distinguerons de cette dernière sous le nom de *Stenophora producta* n. sp. . . . Nous n'avons pas remarqué de ligne èquatoriale à la surface des sporocystes de *Stenophora producta,* ce qui distingue encore cette espèce de *Stenophora iuli.*"

STENOPHORA ACULEATA Léger and Duboscq

[Figures 19 and 20]

1904	*Stenophora aculeata*	Léger and Duboscq 1904:368-70

Stenophora: Sporonts solitary, elongate. Maximum length 60μ; width not given. Ratio length protomerite : total length :: 1 : 4 (approx.); width protomerite : width deutomerite :: 1 : 15. Protomerite subglobular, a short cylindrical portion at the base, somewhat dilated in middle, terminating in a small delicate elongate papilla 1 to 2μ long. A conspicuous constriction at septum. Deutomerite cylindrical, broadly rounded behind. The endocyte of the deutomerite with protoplasmic granules smaller than those of protomerite and less deeply staining. Nucleus very large, subspherical in diameter, two thirds to seven eights the width of deutomerite, with a large karyosome. Cysts and spores unknown.

Taken in Dauphine, France. Host: *Craspedosoma rawlinsii simile* Verh. Habitat: Intestine.

STENOPHORA POLYXENI Léger and Duboscq

[Figure 21]

1900	*Stenophora polyxeni*	Léger and Duboscq 1900:1566-8
1903	*Stenophora polyxeni*	Léger and Duboscq 1903:xciii
1904	*Stenophora polyxeni*	Léger and Duboscq 1904:370-1

Stenophora: Sporonts solitary, obese. Average length 80μ. Width not given. Ratio length protomerite : total length :: 1 : 10; ratio width protomerite : width deutomerite :: 1 : 2 (approx). Protomerite very small, hemispherical or somewhat flattened. No apparent pore in anterior end, as in many Stenophoridae. Protomerite twice as wide as high. Widest at or just above base. Slight constriction at septum. Deutomerite elongate ovoidal in young and sac-shaped in older sporonts. Endocyte fairly homogeneous. Nucleus spherical, half the width of deutomeritet, with a large karyosome. Cyst and spores not known.

Taken at Grenoble, France. Host: *Polyxenus lagurus* (Linn.) Latreille. Habitat: Intestine.

STENOPHORA SILENE Léger and Duboscq

[Figures 22 and 23]

1904 *Stenophora silene* Léger and Duboscq 1904:371-2

Stenophora: Sporonts solitary, dimorphic, an elongate and a globular form. The elongate form 100μ in maximum length, width not given. Ratio length protomerite : total length :: : 1 : 10; width protomerite : width deutomerite :: 1 : 1. Protomerite cylindrical, slightly dilated top and bottom, nearly flattened at top, an apparent pore at apex. Constriction at septum. Deutomerite cylindrical, gradually tapering toward posterior end. Endocyte of protomerite with large achromatic bodies, of deutomerite very finely granular and deeply staining. Nucleus large, half the maximum width of deutomerite, ovoidal, its longitudinal axis parallel to that of body, containing one large karyosome.

The globose form, 55 to 60μ in maximum length. Width not given. Ratio length protomerite : total length :: 1 : 6; width protomerite : width deutomerite :: 1 : 2.3. Protomerite similar to that of elongate form, but containing finely granular endoplasm as deeply staining as that of deutomerite. Deutomerite broadly ovoidal, widest below center. Nucleus less ellipsoidal than in elongate form. Cyst and sports not known.

Taken in Dauphine, France. Host: *Lysiopetalum foetidissimum* Savi. Habitat: Intestine.

> "Howard Crawley (1903) a signalé dans *Lysiopetalum lactarium* des Etas-Unis deux espèces de Grégarines: l'une qu'il nomme *Gregarina calverti* dont la forme générale et la taille sont si differentes de celles de la précédente que l'on ne peut établir de confusion; l'autre espèce est rapportée au *Stenophora iuli.* Il est possible que celle-ci soit identique à notre *Stenophora silene,* mais on ne peut l'affirmer, car Crawley ne donne pas de dimensions de son Stenophora."

Stenophora silene is not the species described by Crawley (1903:51; 1903a:634-5) as *Stenophora juli.* Crawley's species attains a length of 400μ, *S. silene* of only 100μ. The protomerite of *S. juli* is broadly conical, 1.4 times as wide as high; of *S. silene* cylindrical, flattened at the apical end. Crawley's *Gregarina calverti* is still another species, now called *Amphoroides calverti.*

Whether or not there is an actual dimorphism in the Stenophoridae is a problem still far from settled. The finding of elongate and globose forms in the same species and the difference in staining reactions can, I think, hardly be considered sexual dimorphism unless the two sporonts are of somewhere nearly the same size. In *S. silene,* the difference in length of the two is 100%. The difference in lengths of the elongate and globular sporonts is not to be accounted for by a mere shortening of the body, for the staining reaction and shape of the nucleus differ as well. The nucleus of the globular form is less ellipsoidal than that of the elongate form. In all Stenophoridae I have observed, the young trophozoites and younger sporonts have not yet attained that elongation of the nucleus which is characteristic of the adults, and a gradual transition can be observed in the same series of sections from a spherical to sub-spherical and finally to the elongate ellipsoidal nucleus of the adult. In all the gregarines I have studied, the young globular trophozoites contain less protoplasm and stain more readily and deeper than the adults.

If globular and elongate specimens of approximately the same length can be procured or, at least, with protomerites of the same approximate size, and a young cyst shown to contain two individuals with different staining rections and differently shaped nuclei, then there is sexual dimorphism among the Stenophoridae. This has not yet been reported and there is too great a discrepancy in size of the elongate and globose forms to warrant calling them sexually unlike and the phenomenon sexual dimorphism.

STENOPHORA CHORDEUME Léger and Duboscq

[Figures 24 and 25]

1904 *Stenophora chordeume* Léger and Duboscq 1904:372-5

Stenophora: Two forms described for the sporonts. Elongate form 140μ long, width not given. Ratio length protomerite : total length :: 1 : 7.5; width protomerite : width deutomerite :: 1 : 2. Protomerite nearly twice as wide as high, widest along central portion, flattened above, with papilla and an apparent pore at apex. Conspicuous constriction at septum. Deutomerite an elongated irregularly shaped sac widest below the middle and tapering rapidly to a point. Endocyte of protomerite clear, containing large non-staining granules. Endocyte of deutomerite homogeneous with a few scattered irregularly shaped chromatic granules. Nucleus spherical, with a large karyosome.

Globular form with maximum length of 100μ. Width not given. Ratio length protomerite : total length :: 1 : 5; width protomerite : width deutomerite :: 1 : 2.5. Protomerite same shape as in elongate form except that the constriction at septum is deeper and the protomerite sometimes partially invaginated into anterior end of deutomerite. Latter ellipsoidal and nearly spherical. Endocyte of protomerite deeply staining, like that of deutomerite. Latter with long scattered chromatic filaments. Nucleus spherical, with a large karyosome and numerous irregular chromatic granules. Cyst and spores unknown.

Taken at Grenoble, France. Host: *Chordeuma silvestre* C. Koch (*C. sylvestre* C. K.). Habitat: Intestine.

Concerning the long chromatic filaments in the deutomerite, the authors say (1904:374):

> "Sur la signification de ces singulières formations, on ne peut qu'émettre des hypothèses: ou bien ce sont des productions parasitaires, ce qui nous parâit peu probable, car toutes les formes globueuses en montrent à l'exclusion des formes allongées, ou bien ce sont des produits dèrivés de l'activitié cellulaire. Tout en nous rattachant plus volontiers à cette manière de voir, nous ne saurions dire si ces produits prennent naissance dans le cytoplasme comme substances de réserve ou de déchet comparables aux cristalloides déjà signalés chez certaines Grégarines, ou bien s'ils dérivent de la chromatine nucléare. Dans tout les cas, nous ne croyons pas devoir les considérer comme des éléments chromatiques ou chromatides, destinés a jouer un rôle important dans les phénomènes sexuels et nous les regardons plutôt comme des produits ergastoplasmiques."

As heretofore, the size of the two dimorphants is considerable (50%). The deutomerite of the smaller contains many long chromatic filaments. At the same time, the deutomerite of the elongate form is not devoid of scattered chromatin, which may be the broken remnants of threads in a younger stage. Only two diplopods were parasitised, one harbored many parasites; the other on the contrary very few. It is possible, from the limited material at hand, that still longer and more mature elongate forms may exist and bring up the percentage still higher.

For the views of the authors concerning its relationships compare the paragraph quoted under *Stenophora fontaria* (page 60).

From the data given, then, it is impossible to state with certitude that the species are or are not the same. Dimensions correspond closely. I have not included Crawley's species here because of difference in shape of the sporonts but have left it as a distinct species and placed it among the Stenophoridae, the name now being *Stenophora fontaria* (Crawley).

STENOPHORA CORSICA Léger and Duboscq

1903	*Stenophora corsica*	Léger and Duboscq	1903a:314

No description or figure is given for this species. It is merely mentioned as a parasite found in *Craspedosoma legeri* Bröl. at Vizzanova, on the island of Corsica.

STENOPHORA ROBUSTA Ellis

[Figure 26]

1912 *Stenophora robusta* Ellis 1912a:8-10

Stenophora: Sporonts solitary, relatively short and thick. Average length 153μ; minimum length 140μ; maximum 180μ. Width 67μ, as average. Ratio length protomerite : total length :: 1 : 8; with protomerite : width deutomerite :: 1 : 2.5. Protomerite small, dome-shaped or conical. Slight concavity in apical portion, widest at junction with deutomerite. No constriction at septum. Deutomerite broadly ellipsoidal, widest in center, slightly rounded behind. Endocyte fairly clear in all parts but especially so in protomerite. Nucleus spherical, faintly visible or obscured in vivo. One or more karyosomes. Cyst and spores not known.

Taken at Boulder, Colo. Hosts: *Parajulus venustus* Wood; *Orthomorpha gracilis* (Koch); *Orthomorpha sp.* Habitat: Intestine.

STENOPHORA COCKERELLAE Ellis

[Figure 27]

1912 *Stenophora cockerellae* Ellis 1912:681-5

Stenophora: Sporonts solitary, elongate. Average length 500 to 800μ. Minimum length 186μ; maximum 850μ. Width deutomerite not given. Ratio length protomerite : : ::1 : 14.5 to 1 : 17 in adults; width protomerite : width deutomerite :: 1 : 2. Protomerite more or less globose, widest in posterior half. Slightly constricted at septum. Peculiar in that the protomerite protrudes and retracts a short rounded papilla. Deutomerite widest in anterior sixth. Posterior end broadly rounded to square. Endocyte of protomerite pale gray, rather opaque, nearly filling protomerite. Endocyte of deutomerite dense, lead gray to almost black. Nucleus spherical, diameter two thirds the width of deutomerite. Not visible in vivo. Cyst and spores unknown.

Taken at Quirigua, Guatemala. Host: *Orthomorpha coarctata* Intestine.

STENOPHORA ELONGATA Ellis

[Figure 28]

1912 *Stenophora elongata* Ellis 1912:685-6

Stenophora: Sporonts solitary, very elongate. Length 200 to 300μ (average). Minimum length 21μ; minimum 390μ. Width of deutomerite not given. Length of protomerite : total length :: 1: 18 to 1 : 26; width protomerite : width deutomerite :: 1 : 1:6. Protomerite more or less pentagonal (seen from side), truncate, wider than long. Constriction at septum distinct. Deutomerite widest in anterior third, posterior end rounded. Endocyte of protomerite dense, opaque, dark gray; of deutomerite gray, very dense. Nucleus not visible in vivo, spherical, one half to seven eighths width of deutomerite. Cyst and spores unknown.

Taken at Quirigua, Guatemala. Host: *Orthomorpha coarctata* (Saussure). Habitat: Intestine.

STENOPHORA IMPRESSA Watson

[Figure 53]

1915 *Stenophora impressa* Watson 1915:29

This parasite was found to be very common in the intestine of *Parajulus impressus* (Say), one of the common small diplopods found at Urbana, Illinois.

The sporonts are isolated, none being associative. They are elongate ellipsoidal in shape, widest through the central portion of the deutomerite or at the beginning of the posterior two thirds. The protomerite is conical, dilated just above the base and tapering rather acutely but with a blunt point at the apex. The widest part is some little distance anterior to the septum, the constriction at the septum being conspicuous but not deep. The length of the protomerite is about one tenth of the total length of the sporont. The deutomerite broadens gradually from the septum to the central region and then as gradually becomes narrower, ending in a very blunt extremity of much the same general shape as the anterior end of the protemerite. At its widest part, the deutomerite is about twice the greatest width of the protomerite.

The endocyte is gray with no trace of tan. The protomerite contains a few large granules of more or less transparent protoplasm and the deutomerite content is finely granular, homogenous, and often so dense as to appear black in transmitted light. The epicyte is thin, transparent, of even width throughout, and is longitudinally striated. At the anterior end of the protomerite there is an invagination of the epicyte. The latter is here very thin and readily breaks, with a consequent extrusion of the endocyte. The nucleus is spherical, generally visible in the adults and contains one large karyosome which is visible without staining.

The trophozoite of *Stenophora impressa* was studied in sections made of the intestine of the parasitised Parajuli. The young parasites lie imbedded between the cells of the intestinal epithelium, having made a place for themselves by the absorption and destruction of the cell originally entered, and by the absorption, destruction, and pushing aside of contiguous cells; they lie with the apex of the protomerite next the mesothelial wall. As is often the case with the Stenophoridae, there is never developed an epimerite. Since the whole parasite lies embedded, there is abundant surface through which osmosis may take place without the additional presence of an epimerite. The protomerite of trophozoites is often deeply embedded in the deutomerite, like a cork in the neck of a bottle.

Two types of movement were observed. A rapid gliding over the surface at the rate of 6μ per second was very common. This form of movement persists for an hour or more after the animals are placed on the slide. Partial rotation of the body on its own axis and a bending of the body to an angle of about 45° were frequent. The epicyte in the region just below the septum is very flexible, resulting in a nodding of the protomerite from side to side. The extension of the upper part of the deutomerite which causes the protomerite to drop is effected slowly, but withdrawal of protoplasm is done by a sudden jerking movement which restores the normal shape.

Cysts 160μ in diameter were found, but none could be induced to develop to completion in a water medium.

This species differs from *Stenophora lactaria* in a) general shape of the deutomerite, b) shape of the posterior end of the body, and c) shape of the nucleus.

A table of the various dimensions given in microns follows:

Total length of body	155	270	240	270	390	345
Length of protomerite	20	30	25	25	35	30
Length of deutomerite	135	240	215	245	355	315
Width of protomerite	30	35	35	30	48	48
Width of deutomerite	70	70	70	70	115	100
Ratio						
length protom.: total length	1:7.5	1:9	1:10	1:10	1:11	1:11
width protom.: width deutom.	1:2.3	1:2	1:2	1:2.3	1:2.4	1:2.1

STENOPHORA LACTARIA Watson

[Figure 55]

1915 *Stenophora lactaria* Watson 1915:29-30

A gregarine which was found with relative frequency is this one from the intestinal tract of the small diplopod *Callipus lactarius* (Say), taken at Urbana, Illinois, during the month of October, 1914. The infection per host was heavy and sections of the alimentary tract showed the latter half of the same to be heavily parasitised.

A table of various dimensions of the parasites at different ages follows. There is considerable discrepancy in the ratios given but the fact that there is a gradual transition from one extreme to the other indicates that a single species is involved. Measurements were made only of individuals which to all appearances were equally expanded; dimensions are all given in microns:

Total length sporont	175	216	293	304	339	455	480
Length protomerite	28	27	30	30	20	36	30
Length deutomerite	145	189	213	264	319	419	450
Width protomerite	30	30	39	29	39	35	39
Width deutomerite	54	53	90	61	90	65	90
Ratio							
length protom.: tl. length	1:6	1:7.5	1:10	1:10	1:17	1:13	1:16
width prot.: width deut.	1:1.8	1:1.8	1:2.3	1:2.1	1:2.3	1:1.9	1:2.3

The sporonts, as in all members of this family, are solitary until just previous to cyst formation. The body, when moderately expanded, is shaped like a classic vase, widest near the top and tapering very gradually. The protomerite is small in comparison with the deutomerite, being from one eighth (in young specimens) to one sixteenth the total length. It is conical, widest just anterior to the base, and its breadth exceeds its height. (39 by 30μ; 32 by 29μ). It is from 0.4 to 0.6 as wide as the deutomerite at its widest part. There is a slight invagination at the anterior end. The deutomerite is widest a short distance below the conscription at the septum and tapers gradually toward the posterior end, terminating in a blunt cone.

The protomerite is quite or nearly transparent, containing but few large crystal granules of protoplasm which stain deeply. There is an apparent pore at the anterior end. The deutomerite is more or less dense and opaque, being pearly white in reflected light and light or dark gray, depending on the amount of protoplasm present, in transmitted light. The density depends on age, the young trophozoites containing a few pale gray granules, the oldest and largest sporonts being filled with protoplasm which gives to them a blackish appearance. The deutomerite stains a fairly homogeneous shade, and the small granules here do not absorb as much of the stain as do the larger protoplasmic granules.

The epicyte is colorless and very thin, even at the septum. Longitudinal striations are discernible. This epicyte is much more resistant than in many gregarines studied, for animals remain alive on the slide in a water medium or in normal saline for many hours, and when they finally become immotile, retain their shape. After several days on the slide, they have been noted to be intact with the body only a little more nearly globular from osmosis than in the normal parasites. This may be due to the thinness of the epicyte and its great permeability. Myonemes were seen in stained sectioned specimens as deeper staining dots, larger than the deutomerite granules and lying along the periphery of the endocyte in the longitudinal striations.

The nucleus of sporonts is an elongate ellipsoid, generally placed diagonally and reaching almost entirely across that part of the deutomerite in which it lies. In large specimens, it approximates 55 x 30μ. It contains one large spherical or slightly ovoidal karyosome which stains evenly and lightly throughout with Ehrlich's hematoxylin. The nucleus is not visible in vivo in the large and dense individuals. In young specimens, it is spherical, becoming ellipsoidal as the sporont stage approaches.

The trophozoite is much less dense than the sporont. The epimerite is a round, sessile, transparent knob.

The sporozoite is a deeply staining, spindle shaped body which penetrates the cell at is free end, becomes embedded, grows, and absorbs the host cell which it entered. The whole trophozoite, not merely the epimerite, lies embedded and after it has destroyed the originally entered cell distorts and compresses those adjoining. It remains embedded until it has practically outgrown the cells of the epithelium and easily escapes into the lumen through the canal it has formed by cell destruction. The trophozoite is able to move about while embedded. In cross sections of the intestine the parasite, still embedded, is sometimes cut crosswise, indicating that it lies with its longitudinal axis parallel to that of the host, and in one instance it lay with the protomerite pointed toward the lumen rather than toward the mesothelial wall, the normal position.

The gliding movement common to most Polycystids is functional here and the animal moves forward very rapidly in a straight line, often with a constant turning of the protomerite from side to side which affects neither the rapidity nor the direction of motion. Progression has been observed at the rates of 6.5μ and 7.5μ per second. Each of these rates is for a different specimen and each movement extends at a uniform rate over several minutes. No gelatinous stalk was seen trailing the animal either with or without the use of a stain on the slide. Ameboid movement was noted, chiefly confined to the anterior part of the deutomerite; it results in the nodding of the 'head' as many as thirty times without ceasing or decreasing speed. The protomerite does not change in shape or size, neither does the posterior two thirds of the deutomerite. The epicyte of the shoulder region stretches on one side, the endocyte flows into the pocket thus formed, and the inactive protomerite, its equilibrium disturbed, drops to one side and then to the other as the pockets form now on one side and now on the other. Structures which cause movement must therefore be much more numerous or else much more active physiologically in this restricted area than elsewhere.

Cysts are spherical and vary from 150 to 270μ in diameter. I have as yet been unable to procure development of the cysts. A number were kept from two days to two weeks in water and normal saline media and when opened revealed no indication of having undergone progression beyond the dissolution of the walls separating the two conjugants. Staining revealed no differentiation whatever in the apparently homogeneous protoplasm.

This species is distinguished from *Stenophora larvata* (Leidy) Ellis by the considerable difference in size. Leidy's species varies from 100μ to 800μ in length, while *S. lactaria* does not exceed 480μ. His form varies in width from 30μ to 20μ, the other never exceeding 90μ. The ratio of length protomerite : total length in *S. larvata* (largest individual) is 1 : 26; in *S. lactaria* it never exceeds 1 : 16. The nucleus in the former is spherical and about 70μ in diameter; in the latter it is ellipsoidal and smaller, 55 by 30μ in the largest measured. The host is a different diplopod found, however, in the same habitat.

S. lactaria differs from *S. elongata* Ellis and from *S. cockerellae* Ellis in size, shape of the protomerite and deutomerite, and in shape especially of the posterior end of the deutomerite.

STENOPHORA DIPLOCORPA Watson

[Figure 54]

1915	*Stenophora diplocorpa*	Watson	1915:29

A number of most peculiar polycystid gregarines were found in the common small diplopod, *Euryurus erythropygus* (Brandt), at Urbana, Illinois. The parasites were abundant in each of the two specimens examined, each host containing more than a dozen gregarines.

The sporonts are solitary. The shape is more or less cylindrical, the body being very much attenuated. The protomerite is as wide as it is long and is from one-sixteenth to one-twenty-fifth the total length of the body, and there is no indentation at its anterior end as in many of the Stenophoridae. The anterior half of the protomerite is rather broadly conical and is blunt at the apex. There is but a slight constriction at the septum in extended individuals. The anterior end of the deutomerite is but little wider than the protomerite just in front of the septum. The deutomerite gradualy widens, becoming twice the maximum width of the protomerite. It is incompletely separated into two nearly equal parts by a deep constriction at about the middle and behind this constriction the body is cylindrical, of practically the same width throughout, terminating in a blunt, well rounded cone.

The protomerite is transparent or nearly so, containing a few large irregular deeply staining granules clustered near the septum. The deutomerite is plain tan in color and contains smaller homogeneous granules densest just anterior to the constriction in the walls, least dense at the posterior end, and otherwise fairly evenly distributed. The endoplasm is much less opaque than in many gregarines. The epicyte is thick, transparent and of even width throughout except at the constriction in the middle of the deutomerite where it becomes considerably thicker. Longitudinal striations are easily discernible in the epicyte. The myonemes are well developed, especially at the constriction and in the region of the septum, and are indicated by a series of delicate somewhat reticular fibrillae embedded in the peripheral layer of the endocyte and running crosswise of the body. The nucleus is visible in vivo; it is spherical and in diameter two thirds the width of the body just back of the deutomerite constriction. It lies just posterior to this constriction. One large karyosome is visible within.

The epimerite evidently persists after its usefulness is over, and was seen in one instance on a fairly large specimen free in the lumen of the intestine. It is a large hyaline smooth knob with a short stalk broad at the base.

Neither sporozite nor cyst was seen.

The parasite is fairly active. Gliding motion, accompanied by no bodily contortion was observed at rates of 11 and 7μ per second. Each rate was fairly constant for the given gregarine for a period extending over several minutes. A contortion of the body is common, either with no displacement of the body as a whole or in connection with the gliding motion. In fact, it was difficult to find an animal in simple progression which was not at the same time performing some sort of contortion. The region of the septum is very motile. Here the epicyte expands and contracts, with an inflow or withdrawal of the endocyte, just as in the case of an amoeba. Tiny processes can be seen extruded several at a time or a large portion of the endoplasm of the region may be pushed out one at a time. In the latter case, the heavy and rigid protomerite is overbalanced and drops to one side. Immediately thereupon an outpushing of protoplasm on the other side either restores the normal condition or causes a nodding to the opposite side. This movement may continue with surprising rapidity and extend over a long period of time. The deutomerite above its median constriction is very motile, but the portion below is never involved in violent contortions.

This species is similar in general outline to *Stenophora nematoides* Léger and Duboscq (1903a:335-7). Both have the peculiar and hitherto unique constriction at the middle of the deutomerite. They differ in the shape of the protomerite, which in Léger and Duboscq's species is much longer than wide; in the shape of the nucleus, which in *S. nematoides* is elongate ovoidal and in *S. diplocorpa* is spherical; and in the character of movement. I have in no case observed the nematoid shape which is assumed by *S. nematoides* and is due to the elongation of the body and the entire disappearance of the constriction. Motion in *S. diplocorpa* is confined chiefly to regions above the constriction and the latter never entirely disappears.

A table of measurements follows, in which all dimensions are given in microns:

Total length of body	297	325	262	335	359
Length of protomerite	19	20	12	15	14
Length of deutomerite	278	305	250	320	345
Width of protomerite	20	20	20	15	15
Width of deutomerite	45	57	40	45	45
Ratio					
length protom.: total length	1:16	1:16	1:22	1:22	1:25
width protom.: width deutomerite	1:2.2	1:2.8	1:2	1:3	1:3
Diameter nucleus	20	22	18	22	24

CNEMIDOSPORA LUTEA Schneider

[Figures 56 and 57]

1882	*Cnemidospora lutea*	Schneider	1882:446-8

Cnemidospora: Sporonts solitary, elongate. Total length 500μ. Width not given. Ratio length protomerite : total length :: 1 : 15; width protomerite : width deutomerite :: 1 : 1.6. Protomerite subglobular, broader than long, in the ratio of 4 : 3. Divided into two parts, the anterior the shape of a double convex lens, without the characteristic endocyte granules, and tinted greenish; the posterior, larger, portion containing yellow or brown endoplasmic granules. Deep constriction at septum. Deutomerite cylindrical, tapering very slightly and ending in a broad flattened extremity. Endocyte of deutomerite brown, rather dense. Nucleus ellipsoidal, twice as long as wide, containing one or more karyosomes. Myocyte apparent. Cysts not described. Spores ellipsoidal, with a thick integument.

Taken at Poitiers, France. Host: *Glomeris* sp. Habitat: Intestine.

There is but one species in this genus. Crawley (1903a:638-9) described a species as *Cnemidospora spiroboli* but it has been removed to the genus Stenophora, because it has none of the characters of the present genus.

AMPHOROIDES POLYDESMI (Léger) Labbé

[Figure 58]

1892	*Amphorella polydesmi*	Léger	1892:132-4
1899	*Amphoroides polydesmi*	Labbé	1899:20
1903	*Amphoroides polydesmi*	Léger and Duboscq	1903a:314

Amphoroides: Sporonts solitary, ovoidal, rather short and broad. Length 170 – 200μ. Width not given. Ratio length protomerite : total length : : 1 : 20; width protomerite : width deutomerite : : 1 : 26. Protomerite very short, depressed and cup-shaped within. Three times as broad as high. Widest at top, where it is wider than the deutomerite just below septum. A constriction at septum. Septum pushed up in the middle to form a dome which is higher at its summit than the protomerite itself, the latter appearing as a crenulate collar about it. The deutomerite is cylindrical through the anterior third, widening appreciably to form a shoulder, below which it gradually tapers, ending in a broad flattened extremity of approximately the same width as the anterior third of the deutomerite. The endocyte is yellow-brown, the nucleus spherical, its diameter as great as the width of the base of the deutomerite and contains one large karyosome. The epimerite is a cylindroconical or globular papilla. Cysts are spherical, 150μ in average diameter, dehisce by simple rupture and the spores are biconical, 7.8 by 3.8μ.

Taken in the valleys of the Vienne and the Loire, France, and at Vizzanova and Corte, Corsica. Hosts: *Polydesmus complanatus* (L.); *Polydesmus dispar* Silvestri. Habitat: Intestine.

This species was first described by Léger as *Amphorella polydesmi*. The generic name was preoccupied and Labbé changed the name to Amphoroides. At the same time Labbé included with *A. polydesmi* as a synonym *Gregarina polydesmivirginiensis* of Leidy, probably because of the identity of the generic name of the hosts. The character of the protomerites alone would radically differentiate the two species. The latter has since been named *Stenophora polydesmi.*

Labbé says of the Antinocephalidae, to which the genus Amphoroides belongs the members are parasites of the

''tube digestif d'Arthropodes carnaissere''

but the diplopod Polydesmus is surely not carnivorous.

AMPHOROIDES CALVERTI (Crawley) Watson

[Figure 52]

1903	*Gregarina calverti*	Crawley	1903 :48
1903	*Gregarina calverti*	Crawley	1903a :638
1915	*Amphoroides calverti*	Watson	1915 :30

Amphoroides: Sporonts solitary, elongate. Maximum length 1670μ, average length 1400μ, average width 120μ. Ratio length protomerite : total length : : 1 :47; width protomerite : width deutomerite : : 1 :2.5 to 1 : 3. Potomerite greatly compressed in sporonts, shallow, five times as wide as high. Deep crater within the top. Constriction at septum sharp and deep. Deutomerite elongate, widest in anterior third, tapering to a sharp point. Endocyte of protomerite tan in color, not dense; of deutomerite opaque, white. Nucleus small, spherical, not visible in vivo. Myocyte well developed. Cysts spherical, 380μ in average diameter. Dehiscence by simple rupture. Spores not known.

Taken at Wyncote, Pa., and Urbana, Ill. Host: *Callipus lactarius* (Say); *Lysiopetalum lactarium* (Say). Habitat: Intestine.

This species was described by Crawley (1903) as belonging to the genus Gregarina. Later (1903a) he described the cysts and spores as follows:

> "Cysts spherical – – – 250 – 360μ in diameter. – – Dehiscence effected by sporeducts, from 4 to 8 in number, not exceeding in length the diameter of the cyst. – – – Spores doliform, 13 by 5μ. A single thick spore wall. – –"

I have seen one cyst from this species which measured 380μ in diameter and indicated dehiscence by rupture and not by spore ducts. Crawley probably confused the cysts of this species with those of another which may have been developing in the damp chamber at the same time.

This gregarine bears no resemblance to the members of the genus Gregarina whose cysts dehisce by spore ducts, either in its habitat, in a diplopod, or in any of the characteristics of the sporont. The elongate shape, character of movement by slow contortions, great size of the individual, and chiefly the fact that all the animals are solitary tend to prove conclusively that this species is not a member of the genus Gregarina. I think that when the unauthentic species have all been properly placed, it will ultimately be shown that members of the genus Gregarina are all associative during the greater part of their adult sporont life. I place this species in the genus Amphoroides because of the shape of the protomerite.

Appendix to the Stenophoridae

Two and only two species have been described as Stenophoridae which are not parasites in diplopods. These are *Stenophora erratica* (Crawley) (1907:220-8) and *S. gimbeli* Ellis (1913:462-5). The former was placed in this family on very slender evidence, viz.: At the anterior tip of the protomerite is a

> "low papilla within which are traces of a pore. It is this character which led me to place the gregarine in the genus Stenophora."

The author notes later the following (1907:221):

> "The suggestion is permissible that this form is actually the common *Stenophora julipusilli* Leidy, somewhat altered in appearance from being in the wrong host. Crickets and Julidae frequently occur in the same environment, and the former might readily swallow the spores derived from the feces of the latter. This done, the spores might readily develop, although producing slightly atypical gregarines."

The present writer has placed the species in a new genus and called it *Leidyana erratica* (Crawley). For argument relative to this position, see under this species, among the Orthopteran parasites.

Ellis (1913) described from a beetle a parasite he calls *Stenophora gimbeli.*

> "The epicyte of the apex of the protomerite is quite thin and the sarcocyte of this region is driven into a papilla which results from the expansion of the thin epicyte."

Such a papilla has been found nowhere else among the Stenophoridae except in *S. cockerellae.* The present writer has often observed an expansion of the epicyte at the apex of the protomerite after the animal has been on the slide for some time in a water medium and it is due to osmosis and the expansion of the epicyte at its weakest point. This gregarine has been removed from the genus Stenophora and placed in the genus Gregarina. The name now stands *Actinocephalus gimbeli.*

With this disposition of the above two species, the family Stenophoridae is found nowhere outside of the family Diplopoda and the diplopods are parasited almost but not exclusively by the Stenophoridae. It is interesting to note in this connection the fact that very rarely is the same species of gregarines found in more than one species of host. Each species of diplopod may be expected to yield its specific parasite, although this is not without exception.

The species of parasites among the Stenophoridae do not appear to be as widely distributed, i. e. as cosmopolitan, as do those of other gregarines, e. g. of the genus Gregarina, widely separted localities seemingly yielding different parasites from the same host or from closely allied hosts. It is true, however, that much less work has been done in different parts of the world on the diplopod parasites than on those of the beetles and Orthoptera.

One is led to believe that each family of gregarines has its unique order or narrowly restricted orders of insects which it infects and that each genus of gregarine is confined to a single host or to very closely related species.

POLYCYSTID GREGARINES IN THE CHILOPODA*

NAME OF PARASITE	NAME OF HOST
DACTYLOPHORIDAE	
Dactylophorus robustus Léger	*Cryptops hortensis* Leach *Cryptops anomalons lusitanus* Verh.
Nina gracilis Grebnecki	*Scolopendra cingulata* (Latr.)
Nina giardi (Léger) Sokolow	*Scolopendra oraniensis*
Nina giardi corsicum (Léger and Duboscq) Sokolow	*Scolopendra oraniensis lusitanica* Verh.
Nina indicia Merton	*Scolopendra subspinipes* Leach
Echinomera hispida (Schneider) Labbé	*Lithobius forficatus* Linn. *Lithobius coloradensis* Cock.
Echinomera horrida (Léger) Watson	*Lithobius calcaratus* Koch
Acutispora macrocephala Crawley	*Lithobius forficatus* Linn.
Trichorhynchus pulcher Schneider	*Scutigera forceps* (Raf.) *Scutigera* sp.
Rhopalonia geophili Léger	*Himantarium gabrielis* Linn. *Stigmatogaster gracilis* Mein.
Rhopalonia stella Léger	*Himantarium gabrielis* Linn.
ACTINOCEPHALIDAE	
Actinocephalus striatus Léger and Duboscq	*Scolopendra cingulata* Latr.
Actinocephalus dujardini Schneider	*Lithobius forficatus* Linn.
Amphorocephalus amphorellus Ellis	*Scolopendra heros* Giard
Hoplorhynchus actinotus (Leidy) Crawley	*Scolopocryptops sexspinosus* (Say)
Hoplorhynchus scolopendras Crawley	*Scolopendra woodi* Meinert
SPECIES OF UNCERTAIN DETERMINATION	OTHER SPECIES UNNAMED
Trichorhynchus lithobii Crawley	

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*The parasites are arranged in chronological order under each genus.

DACTYLOPHORUS ROBUSTUS Léger

[Figure 29]

1887	*Dactylophorus* sp.	Schneider	1887 :67
1889	*Dactylophorus* sp.	Balbiani	1889 :41
1892	*Dactylophorus robusta*	Léger	1892 :124-7
1899	*Dactylophorus robustus*	Labbé	1899 :17
1903	*Dactylophorus robustus*	Léger and Duboscq	1903 :310-1

Dactylophorus: Sporonts solitary, elongate. Length 700 – 800μ. Width not given. Ratio length protomerite : total length : : 1 : 30. Width protomerite : width deutomerite : : 1 : ½. Protomerite at top approximately twice as wide as deutomerite, broadest at top, six times as wide as high. Periphery of upper margin set with numerous small upwardly directed digitiform processes which constitute the epimerite. Deutomerite elongate, regularly cylindrical in anterior third then becoming much narrower and ending in a long acuminate point. Nucleus ovoidal, twice as long as wide, containing several karyosomes. Endocyte yellow. Cysts spherical, 200μ in diameter, dehiscence by pseudocyst, spores cylindrical, rounded at ends, 11 by 4.3μ.

Taken at Grenoble, France, and on the island of Corsica. Hosts *Cryptops hortensis* Leach; *Cryptops anomalons lusitanus* Verh. Habitat: Intestine.

Labbé (1899 :17) attributed the naming of the genus Dactylophorus to Balbiani. The latter, however, says:

> "C'est d'abord une Grégarine que je crois nouvelle, à moins qu'elle ne soit l'espèce que M. A. Schneider dit avoir découverte chez les Cryptops, et à laquelle il donne le nom de Dactylophorus – – . C'est sans doute la présence de cet appendice qui à valu à notre espèce le nom Dactylophorus, qui lui a été donné par M. Schneider."

Balbiani described a polycystid gregarine from the digestive tract of *Cryptops* sp. as follows:

> "La Grégarine a la forme d'üne massue étroite, étirée en une longue pointe àsa partie postérieure. Sa longueur moyenne est de 0.41 mm. et sa larguer, prise dans la portion renflée du corps, de 0.035 mm. Le segment antérieur ou protomérite est petit, connoidé, et prolongé sur un de ses côtés, en un court appendice obtus dirigé en avant."

Labbé considered this species identical with that later described by Léger as *D. robustus,* probably from the fact that the specimens were taken from the same chilopod (Cryptops). It is evident, however, from figures of the two species, that they are quite unlike. Balbiani's species lacks the dilated flattened protomerite with its digitiform processes, but has rather a high irregular cylindrical protomerite with an eccentric, conical, forwardly directed projection. Moreover, the deutomerite is quite different in shape from that of *D. robustus* (compare Figures 29 and 47) and the nucleus in the one species is spherical, in the other ovoidal. Balbiani's figure compares favorably with figures of sporonts of *Echinomera hispida* (Schneider) Labbé in the following respects; a) the eccentrically placed cone at the apex of the animal, b) the shape of the protomerite, c) the shape of nucleus. In the case of *E. hispida,* the epimerite persists and the cone is a part thereof. Balbiani's figure shows no epimerite, neither does it indicate the digitiform processes characteristic of the other. For these reasons, I do not wish to regard the two species as identical, but rather to leave the one as indefinitely placed. Its original position is obviously incorrect; and the epimerite which is needed to correctly diagnose it not having been discovered, its correct systematic position cannot be determined. Figure 47 is copied from Balbiani's drawing.

NINA GRACILIS Grebnecki

[Figure 30]

1873	*Nina gracilis*	Grebnecki	1873: ?
1887	*Pterocephalus nobilis*	Schneider	1887:68-9
1909	*Nina gracilis*	Léger and Duboscq	1909:33-68

Nina: Sporonts solitary, very elongate. Length 4 to 5 mm. Width not given. Ratio length protomerite : total length :: 1:26; width protomerite : width deutomerite :: 1 : 0.1. Protomerite bilaterally symmetrical, divided into two equal lobes by a perpendicular constriction, these two lobes widely separated at one extremity to form an upturned cornucopia. The free upper extremity of each lobe bordered with a longitudinal row of short sharp spines, from which project long thread-like filaments. Deutomerite constricted just below septum then dilated slightly, the lower half regularly cylindrical, and terminating in a short bluntly pointed extremity. Nucleus slightly ovoidal with several small karyosomes. Csyts spherical. Spores regularly ellipsoidal with one integument, united in chains diagonally.

Taken at Poitiers and at Grenoble (?), France. Hosts: *Scolopendra cingulata* Latr. *(S. cingulata* var. *hispanica* Newp.). Habitat: Intestine.

Labbé (1899:17) says Kölliker's (1849:35) *Gregarina scolopendra,* from *Scolopendra morsitans* Sieb. is probably the same gregarine as the above. But the protomerite is very different from that of the genus Nina and indicates at once Labbé's error. Kölliker gives no description of the epimerite and it is impossible to say in what genus his specimen should be placed. His drawing is reproduced in my Figure 48.

Léger and Duboscq recognize the species and fully discuss its cyst formation.

NINA GIARDI (Léger) Sokolow

1899	*Pterocephalus Giardi*	Léger	1899:390-3
1900	*Nina giardi*	Sokolow	1911:281

Nina: Sporonts solitary, elongate. Length 4 mm. Width not given. Protomerite very broad at the upper extremity, bilaterally symmetrical, consisting of two long parallel horizontal lobes separated at one extremity and upturned at the other, with a small vesicular body near this end. Each lobe set with a row of short upwardly directed teeth from which project long slender sinuous filaments. Deutomerite long, slender, cylindrical, tapering slightly at the posterior extremity and ending bluntly. Cysts spherical. Spores with two envelopes, 14 by 7μ.

Taken at Wimereux, Pas-de-Calais, France. Host: *Scolopendra oraniensis (africana* Verh.) Habitat: Intestine.

NINA GIARDI CORSICUM (Léger and Duboscq) Sokolow

[Figure 31]

1903	*Pterocephalus Giardi corsicum*	Léger and Duboscq	1903a:333
1911	*Nina giardi corsicum*	Sokolow	1911:281-2

Nina: Sporonts solitary, very elongate. Length 2μ. Width not given. Ratio length protomerite : total length :: 1 :10. Ratio width protomerite : width deutomerite :: 4.5 : 1. Protomerite bisymmetrical, formed by two long horns which meet at one end and curve upward nearly 90°. Very wide, 4.5 times maximum width of deutomerite. Extending beyond the deutomerite three times as far on one side as on the other. The periphery of the horns densely set with a row of small denticles with long slender filaments. The shorter lobes thick and blunt. A pseudo-nuclear vacuole near the apex of the opposite lobe, i. e. at the end of fusion. Protomerite transparent. Deutomerite regularly cylindrical, tapering slightly and ending bluntly. Nucleus large, spherical. Cyst and spores not known.

Taken on the island of Corsica. Host: *Scolopendra oraniensis lusitanica* Verh. Habitat: Intestine.

This species differs from *N. giardi* type only in that a) it attains but half the length of the former, b) the confluent lobes of the protomerite are upturned further in the adult, and c) the lobes of the protomerite are shorter and blunter.

NINA INDICIA Merton

[Figure 33]

1911	*Nina indicia*	Merton	1911:119-26

Nina: Sporonts solitary, elongate. Length $500\mu - 1500\mu$. Width not given. Ratio length protomerite : total length :: 1 : 20; width protomerite : width deutomerite :: 4 : 1. Protomerite bilaterally symmetrical, low and very broad, eight times as wide as high, formed of two long sinuous narrow plates separated at one end for a very short distance. Each bearing a narrow ridge at the upper margin set on both sides with short sharp teeth. The two ridges never confluent but nearly parallel throughout their length. Deutomerite elongate, irregularly cylindrical, dilated a short distance below the septum and tapering from the middle to a long slender and pointed posterior extremity. Endocyte dense in deutomerite, much less dense in protomerite. A deeply staining vesicle at one end of protomerite. Nucleus spherical with chromatin arranged in one convoluted band. Cyst and spores not described.

Taken at Heidelberg, Germany. Host: *Scolopendra subspinipes* Leach. Habitat: Intestine.

ECHINOMERA HISPIDA (Schneider) Labbé

[Figure 32]

1875	*Echinocephalus hispidus*	Schneider	1875:293-4
1899	*Echinomera hispida*	Labbé	1899:16

Echinomera: Sporonts solitary, obese. Measurements not given in the literature. Ratio length protomerite : :total length :: 1 : 7 to 1 : 11; width protomerite : :width deutomerite :: 1 : 2 to 1 : 2.4. Protomerite broad, flattened, surmounted by a persistent epimerite in the form of an irregular asymmetrical cone as broad at its base as the protomerite and terminating in an eccentrically placed point. Sides of this cone set with eight digitiform, upwardly directed processes. Deutomerite regularly ellipsoidal, widest in the anterior half or nearly globular, terminating in a broadly rounded extremity eight to ten times the length of the epimerite and protomerite together. Endocyte dense, finely granular, with spherical karyosomes. Cysts are described in the literature as spherical, dehiscence by simple rupture. Spores elongate cylindrical, united in chains. Dimensions not given.

Taken at Paris, France; Cambridge, Mass.; Wyncote, Pa.; Raleigh, N. C.; and Boulder, Colo. Hosts: *Lithobius forficatus* Linn. *(L. forcipatus)* and *Lithobius coloradensis* (Cock.) Habitat: Intestine.

Crawley (1903:52) found this gregarine rather common in *Lithobius forficatus* in eastern United States, and Ellis (1913:465) found it in the West. Neither gives figures of the species. Since Schneider gave no dimensions, these writers based their determination on a comparison of their material with his figures. Ellis gives these measurements: length 180μ, width 80μ. He says

> "– – processes of the epimerite disappearing shortly after the animal frees itself from the intestinal wall of the host, but the conical part – – – persists in the sporont stage, giving a symmetrical margin to the front of the protomerite."
>
> "In some specimens the ratio of the length of the protomerite to the length of the deutomerite was as low as one to seven, while Schneider's original figures give it as one to eleven or more. Other specimens seemed intermediate between *E. hispida* (Schn.) and *E. horrida* (Léger). It seems probable then that *E. horrida* (Léger) is synonomous with *E. hispida,* leaving a single species in this genus."

That Ellis found the ratio of length protomerite : length deutomerite as low as 1 : 7 is not out of harmony with Schneider's proportions of *E. hispida,* for the latter says

> "Deutomérite huit à dix fois environ plus long que le segments superieure réunis – – –."

E. horrida is much more nearly globose than such proportions indicate and there is no good argument for considering the two species synonymous.

Half a dozen specimens of *Lithobius forficatus* were examined at Oyster Bay, L. I., in October, 1915 and three of them were found to be parasitised with this species. (Figs. 270, 272). From ten to fifty adult parasites were found in the intestine of each host. This species is readily recognized by its intense black color. The specimens are small, the maximum length seen being 330μ, and the maximum width

120μ. The ratio of length protomerite : total length was 1 : 7 and the ratio of width protomerite : width deutomerite was 1 : 2. The sporonts are solitary, and characterized by the possession of a short eccentric conical projection from the protomerite, which is slightly mobile. The protomerite is constricted conspicuously in a horizontal direction at about its middle portion. The protoplasm above this constriction is sparse and transparent; below, it is a little more dense and tan; in the deutomerite it is very dense and black, and the nucleus is not visible.

Cysts were found to be ovoidal in shape and measured 320 by 270μ. Spores were not seen. A table of measurements in which all dimensions are in microns is given here:

Length sporont	330	330	270
Length protomerite	40	50	40
Length deutomerite	290	280	230
Width protomerite	50	60	60
Width deutomerite	120	120	120
Ratio			
length protom.: total length	1:8.2	1:6.6	1:7
Width protom.: width deutomerite	1:2.4	1:2	1:2

ECHINOMERA HORRIDA (Léger) Watson

1899	*Echinocephalus horridus*	Léger	1899:390-5
1911	*Echinocephalus horridus*	Sokolow	1911:281
1916	*Echinomera horrida*	Watson	(This paper)

Echinomera: Sporonts ovoidal, almost spherical, 100-150μ in length. Width not given. Protomerite in shape of a narrow elongate blunt cone, the apex eccentric and carrying a papilla which represents a primitive epimerite. Cysts spherical or cylindrical, rounded at ends.

Taken at Wimereux, France. Host: *Lithobius calcaratus* Koch. Habitat: Intestine.

ACUTISPORA MACROCEPHALA Crawley

[Figure 34]

1903	*Acutispora macrocephala*	Crawley	1903a:632-3

Acutispora: Sporonts solitary, elongate. Maximum length 600μ, width not given. Ratio length protomerite : total length :: 1 : 3; width protomerite : width deutomerite :: 1 : 1.3. Protomerite one-third the length of the sporont. Conical papilla at apex, deep constriction in posterior third and a constriction of equal depth at septum. Deutomerite just behind septum wider than protomerite just in front of it, regularly conical, tapering from shoulder to a blunt point. Endocyte dense. Nucleus not visible. Cysts spherical, 410μ in diameter, dehiscence by pseudocyst. Spores navicular, slightly curved, slender, two integuments, thin and blunt refractile rod of endocyte at each end, 6μ long; spores 19 by 4μ.

Taken at Raleigh, N. C. Host: *Lithobius forficatus* L. Habitat: Intestine.

The genus Acutispora was created by Crawley for this unique species.

TRICHORHYNCHUS PULCHER Schneider

[Figures 35, 36]

1882	*Trichorhynchus insignis*	Schneider	1882:439-42
1882	*Trichorhynchus pulcher*	Schneider	1882:439-42
1889	*Gregarina megacephala*	Leidy	1889:10-11
1899	*Trichorhynchus pulcher*	Labbé	1899:16

Trichorhynchus: Sporonts solitary, elongate, length 420 to 750μ; width 240μ. Ratio length protomerite : total length :: 1 : 4 to 1 : 7. Width protomerite : width deutomerite : 1 : 1 to 1 : 1.6. Epimerite nearly half the total length of body without it. Protomerite conical, rounded at summit. Slight constriction at septum. Deutomerite just below septum same width as protomerite just above it, widest in anterior third. Constricted below middle portion then dilated and ending in a broad but sharply pointed cone. Epimerite a very long flexible 'tongue' proceeding from the apex of the protomerite, slightly dilated at the extremity. Endocyte in both parts dense. Nucleus ovoidal with one large karyosome. Cysts ovoidal, 316 by 303μ. Dehiscence by pseudocyst. Spores cylindrical, rounded at ends, 9.7 by 5.8μ.

Taken at Poitiers, France; Philadelphia, Pa. Hosts: *Scutigera,* sp.; *Scutigera forceps* (Raf.) *(Cermatia f.).* Habitat: Intestine.

This gregarine was described by Schneider under the name *T. insignis,* but his references to his plates are to figures of *T. pulcher.* It was probably an error in the proof which was accountable for the incorrect naming of the species, for the name of the species immediately preceding is *Lophocephalus insignis.*

Labbé referred to the species as *T. pulcher.*

Crawley referred the gregarine which was described by Leidy as *G. megacephala* (Fig. 35) to the present species because of the elongate appendage on the protomerite. That this position is correct is attested by the fact that Crawley himself found the species, the specimens agreeing with Schneider's figures and with the dimensions as given by Leidy. Crawley's description is as follows:

> "This form is well described by A. Schneider whose figure also is excellent, giving a very accurate idea of the actual animal. Schneider, however, gives no dimensions, while Leidy says that the dimensions vary from 420 to 750 microns, these figures agreeing very closely with those which I obtained.
>
> "My own observations on this species show it to be an active, very polymorphic gregarine, with the ability to undergo extensive alterations in shape. Thus, the anterior end of the protomerite, normally a blunt curve, frequently protrudes in a long tongue-shaped process. The peristaltic movement so frequently displaced by gregarines, may, in this species, pass forward as well as backward. This indicates that here the contractile elements are capable of operating as well in one direction as another, which is certainly not the case in most polycystid gregarines. Fusion, preparatory to encystment, was seen to take place 'head to head.'"

Leidy's brief account of the species is as follows:

> "One morning – – I found a fine *Cermatia forceps* in my bedroom. It was – – species which may be named *Gregarina megacephala.* The body is elongated ovate and acute or short clavate and obtuse with an unusually large ovoid and often constricted head, surmounted by a small rounded or elongated appendage. Length 0.42 to 0.75 mm. by 0.24 broad; head about one-fourth the length of the body. It approximates *Dufouria agilis* of Schneider, found in the larvae of a Hydracantharis."

The latter species lacks the elongated proboscis; it is now known as *Legeria agilis* (Schn.) Labbé. For description and drawing, see chapter on Coleoptera.

RHOPALONIA GEOPHILI Léger

[Figure 51]

1894	*Rhopalonia geophili*	Léger	1894:1285-88
1896	*Rhopalonia geophili*	Léger	1896:29

Rhopalonia: Sporonts solitary, dicystid, obese. Widest at anterior end, tapering to a point. Length 500μ. Epimerite a large hyaline subspherical plate with a corona of ten to fifteen backwardly directed digitiform processes placed above the protomerite on a short neck. Endocyte with large yellow-orange granules. Nucleus ovoidal, containing several karyosomes. Cysts spherical, 200 to 250μ, the fertile half brown, the sterile half white, a black equatorial band marking the future line of dehiscence. Spores cylindrical, rounded at ends, double walled, 16 by 6.5μ.

Taken in Provence, France and on the island of Corsica. Hosts: *Himantarium gabrielis* Linn. *(Geophilus g.); Stigmatogaster gracilis* Meinert. Habitat: Intestine.

This parasite is peculiar in having no septum in the adult sporont and thus no protomerite and deutomerite. A rudiment of a protomerite is indicated by a finely granular yellow mass at the proximal end of the body, separated from the rest of the sporont by a clear area. Léger thinks this genus is transitional between the Cephalina and the Acephalina. His words are as follows:

> "La Grégarine est donc, au point de vus èvolutif, une dicystidée vraie, c'est-a-dire n'ayant jamais plus de deus segments; auu apparail de fixation caduc et un segment unique persistants (pseudo-monocystis) representant à la fois le protomérite et le deutomérite des tricystidés. Elle se rapproche en cela des grégarines intestinales des vers marine."

Léger and Duboscq (1903:311) found a parasite on the island of Corsica which may be the *Rhopalonia geophili* of Léger.

> "Les Stigmatogaster d'Ajaccio contenaient dans leur intestin de rares sporadin en forme de toupie, surmountés au pôle antérieur d'un plateau circulaire bordé d'un bourrelet saillant. Nous les rapportons avec quelque doute an *Rhopalonia geophili* Léger, fréquent dans les *Stigmatogaster gracilis* de Provence et dont les sporadins sont généralement de forme plus allongée."

RHOPALONIA STELLA Léger

1899 *Rhopalonia stella* Léger 1899:390-5

Rhopalonia: Sporonts solitary, ovoidal, elongate or spindle shaped. Length about 130μ, width not given. Body not differentiated into protomerite and deutomerite. The epimerite is like that of *R. geophili* Leger and '' – – rapelle assez bien une fleur de syanthérés.'' (Sokolow 1911 :281).

Host: *Himantarium gabrielis* Linn. Habitat: Intestine.

The comparison of the epimerite with the flower of one of the Compositae is a good one, as seen in Figure 51.

ACTINOCEPHALUS STRIATIUS Léger and Duboscq

[Figure 37]

1903 *Actinocephalus striatus* Léger and Duboscq 1903a:334-5

Actinocephalus: Sporonts solitary, minute. Length 30 – 35μ. Width not given. Ratio length protomerite : total length : : 1 : 4; width protomerite: width deutomerite : : 1 :.7. Protomerite wider than deutomerite, dome shaped, broadly rounded in front with a small flattened circular papilla surrounded by a circle of small teeth. Constriction at septum, which is curved upward. Deutomerite irregularly cylindrical, terminating in a sharp cone. Epicyte marked with very apparent longitudinal striations, from whence the name. Nucleus ovoidal with its longitudinal axis perpendicular to that of the body. Cyst and spores unknown.

Taken in Provence, France. Host: *Scolopendra cingulata* Latrielle. Habitat: Intestine.

This gregarine is placed in the genus Actinocephalus from the character of the dentate papilla of the protomerite.

"– – – au sommet du protomérite fait saillie un petit bouton aplati, à bord régulièrement festonné, comme dentelé, au centre dupuel s'élève un rostre mobile asset droit. C'est là l'epimérite qui, comme on le voit, présente de grandes analogies avec celui des Actinocephalus."

ACTINOCEPHALUS DUJARDINI Schneider

[Figures 38, 39, 40]

1875 *Actinocephalus dujardini* Schneider 1875:589-90

Actinocephalus: Sporonts solitary, rather obese. Length and width not given. Ratio length protomerite : total length : : 1 : 2.4; width protomerite : width deutomerite : : 1 :1. Protomerite very large, cylindrical, longer than wide, nearly one third total length of sporont, terminating in a truncated cone, the apical region being hyaline, slight constriction at septum. Deutomerite widest just behind the septum and tapering gradually to a sharp point. Endocyte of equal density in protomerite and deutomerite. Epimerite a globose sessile body resting on the apex of the protomerite, drawn out in its apical region to a short neck upon which is set a flat corona of 16 to 20 backwardly directed rigid spines. Nucleus small, spherical. Cyst and spores not known.

Taken at Paris, France. Host: *Lithobius forficatus* Linn. *(L. forcipatus)*. Habitat: Intestine.

Crawley (1903:55) records finding this little gregarine several times in *L. forficatus.* He gives no drawings and does not state where it was taken.

AMPHOROCEPHALUS AMPHORELLUS Ellis

[Figures 45, 46]

1913	*Amphorocephalus amphorellus*	Ellis	1913:463-4

Amphorocephalus: Sporonts solitary, elongate, length 500 to 970μ, width not given. Ratio length protomerite : total length :: 1 : 1.7; width protomerite : width deutomerite : 1 : 2.5. Protomerite dome shaped, broadly rounded in front, a distinct constriction near middle. Deutomerite cylindrical, tapering slightly to a sharp point. Endocyte dense, nearly black. Epimerite flask-shaped with fluted apical disc, sessile on the protomerite, persisting on large free cephalonts. Nucleus not noted. Cyst and spores not seen.

Taken at Boulder, Colo. Host: *Scolopendra heros* Giard. Habitat: Intestine.

This genus contains the unique species above. It is characterized by the flask-shaped epimerite with finger-like processes at the apex and by the protomerite having a constriction at the middle, extending horizontally around the same.

HOPLORHYNCHUS ACTINOTUS (Leidy) Crawley

[Figures 42, 43]

1899	*Gregarina actinotus*	Leidy	1889:10
1903	*Hoplorhynchus actinotus*	Crawley	1903:55-56
1913	*Amphorocephalus actinotus*	Ellis	1913b:277

Hoplorhynchus: Sporonts solitary. Maximum length recorded that of Leidy, 520μ, maximum width 80μ. Crawley's maximum recorded length, 485μ, width 105μ. Ratio length protomerite : total length :: 1 : 9 (Leidy) to 1:12 (Crawley); width protomerite: width deutomerite :: 1 : 2 (Leidy and Crawley). Protomerite dome shaped, twice as broad as high. Deutomerite roughly triangular, wider than protomerite at septum. Attaining maximum width at shoulder, thence tapering to a more or less sharp point. Epimerite 80 to 100μ long, vase shaped, broadest near base and tapering to a neck where it again widens into a broad disc of short digitform processes from 8 to 20 in number. Crawley says:

> "– – amphora shaped. Differentiated in front into four dichotomously branched lobes. – – In the small animals making up nearly 1/2 the total length; in the adults from 1/4 to 1/5 of the total length."

Endocyte dense and opaque. Nucleus ovoidal, diagonally placed. Cyst and spores not known.

Taken at Philadelphia, Wyncote and Wallingford, Pa., and Raleigh, N. C. Hosts: *Scolopocryptops sexspinosus* (Say) and *Scolopocryptops* sp. Habitat: Intestine.

Crawley (p. 56) says:

> "Apparently in this gregarine the septum tends to disappear. It is much more evident in some cephalonts than in others, and in one sporont seen no septum could be made out, and the endocyte of the protomerite was not distinguishable from that of the deutomerite."

Ellis (1913b) placed this gregarine in his genus Amphorocephalus. He characterizes the genus as follows:

> "Protomerite with a constriction near the middle dividing it into two lobes, the anterior of which is the smaller; epimerite longer than wide, but not extremely elongate, widest in its posterior third, narrowed at its junction with the protomerite terminating in a somewhat concave enlargement, the edge of which has a fluted appearance because of the presence of numerous small finger-like processes; deutomerite elongate."

It is readily seen that the species in question does not fit this generic diagnosis for the following reasons: 1) the protomerite is not constricted in the middle, with a small anterior part; 2) the epimerite is elongate, from two to four times as long as wide (in Ellis' described species it is but little longer than wide, 1 :1.2); 3) the apex does not terminate in a broad disc, the edge of which has a fluted appearance, because of the presence of numerous small finger like processes, but terminates in a disc edged with dichotomously branched distinctly separated digitiform processes, from eight to twenty in number; 4) the deutomerite is not elongate as in Ellis' figure, in which it is from eighteen to twenty-two times the length of the protomerite, but is only from six to twelve times the length of the protomerite. I have therefore replaced the species in the genus designated by Crawley.

HOPLORHYNCHUS SCOLOPENDRAS Crawley

[Figure 41]

1903	*Hoplorhynchus scolopendras*	Crawley	1903a :636-7
1913	*Amphorocephalus actinotus*	Ellis	1913b :277

Crawley's description of the species is quoted:

> "This species is created for a gregarine parasitic in *Scolopendra woodi* Meinert from Raleigh, N. C. Two specimens were present. One of these, when first

> seen, was a balloon-shaped sac, 350μ long by 200 broad. The epicyte and sarcocyte were each nearly or quite 3μ thick, and the former was plainly marked with longitudinal striations. Both of the individuals were very flexible, readily changing shape and showing extensive contortions. After having been upon the slide for perhaps an hour, the parasites became quiescent and assumed what was probably something like the typical shape. The larger then measured 825μ long by 120 broad. The anterior end, as shown in figure 19, was much narrower than the balance of the animal, but it is somewhat questionable if this narrowing is permanent. A distinct septum extended across this narrower region, cutting off a portion of granular entocyte. Backward from the broadest portion, the animal's body tapered gradually, ending behind in a point. This species is placed in the genus Hoplorhynchus on account of its close resemblance to *H. actinotus* Leidy and its occurrence in a centipede related to Scolopocryptops, the host of the latter."

Its position is doubtful from insufficient evidence and will not remain authentic unless corroborated and described in more detail by some future worker.

Ellis included this species with *H. actinotus* under the name *Amphorocephalus actinotus* (Leidy). I have referred the species to the original position. The protomerite does not have the constriction necessary to place it in the genus Amphorocephalus.

SPECIES OF UNCERTAIN DETERMINATION

TRICHORHYNCHUS LITHOBII Crawley

[Figure 44]

Crawley's statement (1903a:637) concerning this species is as follows:

> "This animal, which is apparently specifically distinct from any other gregarine parasitic in Lithobius, was found in a specimen of that centipede from Raleigh, N. C. An epimerite was not found. The protomerite was subcordiform, and displayed in front a differentiation the exact nature of which could not be determined. The deutomerite varied considerably in shape, the animal being quite polymorphic. Both epicyte and sarcocyte were distinct and of about equal thickness. The septum was thick and curved backward. The endocyte was not dense; the nucleus large, with several karyosomes. The largest individual seen was 195μ long."

There seems to be no basis for placing the parasite in the named genus. None of the characteristics of the genus are named above, the elongate epimerite, ovoidal cysts which dehisce by pseudocyst, cylindrical spores. Enough data are lacking so that the species cannot be definitely placed in any genus.

A parasite is described by Léger and Duboscq (1903a:312) but not named. It was found on the island of Corsica, in *Chaetechelyne vesuviana* Newport. Their statement in full follows:

> "Sur plusieurs individis examinés, un seul (d'Ajaccio) était parasité par une Grégarine recontrée seulement au stade de sporadin. Sous cette forme, la Grégarine est allongée et mesure 100µ. Le deutomérite est, dans sa partie antérieure, plus large que le protomérite dont il atteint 5 ou 6 fois la longuer, puis il va en s'atténuaît pour se terminer en pointe pousse. Ces caractēres ne sont pas suffisants pour rapporter ces sporadins à un Rhopalonia plutôt qu' à un Actinocephalus."

A third species of indeterminate situation is that called by Balbiani *Dactylophorus* sp. (1889:41). This species has been discussed in detail under the heading *Dactylophorus robustus* (Léger) Labbé, and is illustrated in Figure 47.

A fourth species of doubtful position is that described by Kölliker as *Gregarina scolopendra* (Figure 48). See discussion under *Nina gracilis* Grebnecki.

POLYCYSTID GREGARINES IN THE ORTHOPTERA*

Name of Parasite	Name of Host
GREGARINIDAE	
Gregarina oblonga Dufour	*Oeipoda stridula* *Oedipoda migratoriae* *Gryllus campestris*
Gregarina hyalocephala Dufour	*Tridactylus variegatus*
Gregarina ovata Dufour	*Forficula auricularia* L.
Gregarina blattarum Siebold	*Periplaneta orientalis* (L.) *Periplaneta americana* (L.) *Blatella germanica* (L.)
Gregarina locustae Lankester	*Dissosteria carolina* (L.)
Gregarina oviceps Diesing	*Gryllus abbreviatus* Serv. *Gryllus americana* Blatch.
Gregarina macrocephala (Schn.) Labbé	*Nemobius sylvestris* (F.) *Gryllus domesticus* (L.)
Gregarina panchlorae Frenzel	*Panchlora exoleta* Klug
Gregarina acridiorum Léger	*Tryxalis* sp. *Pamphagus* sp. *Sphingonotus* sp.
Gregarina paranensis (Kunckel d' Hercularis) Watson	*Schistocera paranensis*
Gregarina serpentula deMagalhaes	*Periplaneta orientalis* (L.)

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*The parasites are arranged in chronological order under each genus.

Gregarina rigida (Hall) Ellis	*Melanoplus differentialis* (Uhler)
	M. femur-rubrum (deGeer)
	M. atlanis (Riley)
	M. coloradensis ?
	M. bivitattus (Say)
	M. angustipennis (Dodge)
	M. femoratus (Burm.)
	M. luridis (Dodge)
	Hesperotettix pratensis Scudder
	Schistocera americana Burm.
	Brachystola magna Giard
	Encoptolophus sordidis (Burm.)
Gregarina kingi Crawley	*Gryllus abbreviatus* Serv.
Gregarina longiducta Ellis	*Ceuthophilus latens* Scudder
	C. maculatus (Say)
Gregarina consobrina Ellis	*Ceuthophilus valgas* Scudder
Gregarina illinensis Watson	*Ischnoptera pennsylvanica* (deGeer)
Gregarina galliveri Watson	*Gryllus abbreviatus* Serv.
Gregarina stygia Watson	*Ceuthophilus stygius* (Scudder) L.
Gregarina nigra Watson	VARIOUS ACRIDIDAE
Gregarina udeopsylla Watson	*Udeopsylla nigra*
Leidyana erratica (Crawley) Watson	*Gryllus abbreviatus* Serv.
	Gryllus pennsylvanica Burm.
Leidyana gryllorum (Cuénot) Watson	*Gryllus domesticus* (L.)
Hyalospora roscoviana Schneider	*Petrobius maratimus*
Hyalospora affinis Schneider	*Machilus cylindrica* E. Geoff.
Gamocystis tenax Schneider	*Blatella laponica*
Hirmocystis gryllotalpa (Léger) Labbé	*Gryllotalpa gryllotalpa* (L.)
ACTINOCEPHALIDAE	
Pileocephalus blaberae (Frenzel) Labbé	*Blabera clarziana* Sauss.
Actinocephalus fimbriatus (Diesing) Ellis	*Dissosteria carolina* (L.)
INDETERMINATE SPECIES	
Gregarina conica Dufour	*Coleoptera* and *Gryllus*
Gregarina davini Léger and Duboscq	*Gryllomorpha dalmatina* Ocsk.
MISCELLANEOUS	
Gregarina sphaerulosa Dufour	
Gregarina soror Dufour	

GREGARINA OBLONGA Dufour

[Figures 177, 178]

1837	*Gregarina oblonga*	Dufour	1837:13
1848	*Gregarina oblonga*	Frantzius	1848:195
1851	*Gregarina oblonga*	Diesing	1851:11
1863	*Gregarina oblonga*	Lankester	1863:94

The only description extant is the original one of Dufour, which is as follows:

> "Oblonga flavescens conico-cylindroidea; cephalothorace abdominis quintam partem vix adeaquante.
>
> Hab—Oedipodae migratoriae et Grylli campestris.
>
> Beaucoup moins conique la G. conique elle a une couleur jaunâtre qui ne s'observe pas dans les autres espèces."

Here, as in the case of *Gregarina conica,* Dufour confused more than one species under a single name. Oedipoda is a genus of the order Diptera and also of the Orthoptera. If the Dipteran order is meant, the same species of gregarine would not be looked for in both Diptera and Orthoptera. Such an instance has not yet been recorded for a single species.

Dufour's drawings from both insects are, however, similar and are reproduced in my Figures 177 and 178, although the protomerites are slightly different in their relation to the deutomerites.*

Frantzius lists the species as from Oedipda only. He places it in the same genus Gregarina ''stets zu zwei aneinander geheftet.''

Diesing mentions it with hosts as *Oedipoda migratoria* and *O. stridula,* and from *Gryllus campestris.*

Lankester gives the host as Gryllus. After this mention, the species passes out of the literature. I have listed it among the parasites of the genus Gregarina because Dufour states

''cephalothorace abdominis quintam partem''

and because Frantzius lists it among the parasites with both primite and satellite.

This species may be identical with *Gregarina macorcephala* Schn. from the identity of one of the hosts, but the two cannot be correlated. Dufour describes only sporonts and Schneider only cephalonts and until the cephalonts of the former or the sporonts of the latter or both will have been described, the two species must remain separate.

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*I have not attempted to separate the parasite in the two hosts as two species from the meager description we have, but have recorded this species in this chapter as well as in Part III, a list of Polycystid Gregarines, under the Diptera.

The only other parasite described from a host belonging to the subfamily Oedipodinae (Acrididae) is *Gregarina locustae* Lankester, but the sporonts of the two species are not identical.

The second host named is now known as *Nemobius sylvestris* (F.).

GREGARINA HYALOCEPHALA Dufour

[Figures 181, 182]

1837	*Gregarina hyalocephala*	Dufour	1837:13
1851	*Gregarina hyalocephala*	Diesing	1851:11
1863	*Gregarina hyalocephala*	Lankester	1863:94
1899	*Gregarina hyalocephala*	Labbé	1899:34

Dufour's description is as follows:

> "Oblongo-conica; cephalothorace hemispherico diaphano, abdominis quartam partem subadaequante – –. Hab. in ventriculo Tridactyli."

The species is, from this description, and from the character of the epimerite (Figure 182) quite evidently a member of the genus Gregarina.

Frantzius does not mention the species; Diesing and Lankester merely do so and Labbé places it among his Uncertain Species.

GREGARINA OVATA Dufour

[Figure 183]

1826	*Gregarina ovata*	Dufour	1826:18
1837	*Gregarina ovata*	Dufour	1837:12
1837	*Gregarina ovata*	Siebold	1837:408
1838	*Clepsidrina conoidea*	Hammerschmidt	1838:356
1845	*Gregarina ovata*	Desmarest	1845:?
1848	*Gregarina ovata*	Frantzius	1845:95
1851	*Gregarina ovata*	Diesing	1851:10
1863	*Gregarina ovata*	Lankester	1863:94
1873	*Clepsidrina ovata*	Schneider	1873:515-33
1885	*Clepsidrina ovata*	Schneider	1875:578-9
1875	*Clepsidrina ovata*	Schneider	1885:?
1899	*Gregarina ovata*	Labbé	1899:10
1904	*Gregarina ovata*	Paehler	1904:14-18
1905	*Clepsidrina ovata*	Schnitzler	1905:309

Gregarina: Sporonts biassociative. Measurements not given in any description. Ratio length protomerite : :total length primite : :

1 : 5 to 1 : 6; width protomerite : width deutomerite : : 1 2. Protomerite of primite hemispherical, slightly constricted at septum. Protomerite of satellite flattened. Deutomerite ovoidal, widest below middle in primite, above middle in satellite. Posterior end rounded. Nucleus spherical with many small karyosomes, visible in vivo. Epimerite a simple hyaline knob.

Cysts spherical or slightly ovoidal, dehiscence by sixteen, more or less, spore ducts; spores cylindrical, truncate at ends (not barrel shaped), macrospores and microspores (15.8 by 7.9; 8.3 by 3.7μ).

Taken in France, and in Berlin and Danzig, Germany. Host: *Forficula auricularia* L. Habitat: Intestine.

Dufour designated as hosts *Gryllus campestris* and *Forficula.* He gave a good figure of biassociative sporonts taken from Forficula, and a figure of a single sporont from Gryllus which differs considerably in shape from the other and probably represents another species, although I have not attempted to place it systematically.

Siebold accidentally found this species in Forficula but he did not think the organisms were animals, for no motion was observed.

Frantzius represented an accurate figure of the species. He named Forficula as host, recognizing Dufour's error in including a parasite from Gryllus.

Diesing indicated that Hammerschmidt had described a synonymous species, *Clepsidrina conoidea,* from the same host. He also included as a synonym *G. psocorum Sieb.* but from the fact that the host, *Psocus quadripunctatus,* is a Neuropteran, I doubt the authenticity of this statement. Siebold's paper is not available and the conjecture cannot be verified.

Schneider agreed with Diesing that *Clepsidrina conoidea* is a synonym of *Gregrina ovata.* He discussed at length (1873) the cyst formation in this species. In 1885, he worked upon the species in greater detail, finding and giving measurements of two kinds of spores.

The species was the subject of a monograph by Paehler in 1904.

I have examined about fifty specimens of *Forficula auricularia* L. at Cold Spring Harbor, L. I., without finding parasites.

GREGARINA BLATTARUM Siebold

[Figure 184]

1839	*Gregarina blattarum*	Siebold	1839:57
1848	*Gregarina blattarum*	Stein	1848:223
1848	*Gregarina Blattarum*	Frantzius	1848:193,195
1851	*Gregarina Blattarum*	Diesing	1851:10
1853	*Gregarina Blattae orientalis*	Leidy	1853:239
1863	*Gregarina blattarum*	Lankester	1863:94
1875	*Clepsidrina blattarum*	Schneider	1875:580
1881	*Gregarina blattarum*	Bütschli	1881:384-409
1891	*Gregarina blattarum*	Wolters	1891:115-24
1893	*Gregarina blattarum*	Marshall	1893:25-45
1899	*Gregarina blattarum*	Labbé	1899:10
1900	*Clepsidrina blattarum*	deMagalhaes	1900:38-44
1903	*Gregarina blattarum*	Crawley	1903:44
1907	*Gregarina blattarum*	Hall	1907:149
1913	*Gregarina blattarum*	Ellis	1913b:265
1913	*Gregarina blattarum*	Ellis	1913c:83-84

Gregarina: Sporonts biassociative, rather stout bodied, more or less irregular in outline. Length of sporonts 450 to 500μ. Width 185 to 200μ. Ratio length protomerite : total length primite :: 1 : 5; width protomerite : width deutomerite :: 1 : 2. Protomerite of primite cylindrical in posterior two thirds, rounded anteriorly, no constriction at septum. Very little wider than high. Protomerite of satellite flattened, wider than protomerite of primite, twice as wide as high. Deutomerite irregularly cylindrical, widest in posterior half of primite and in anterior half of deutomerite. More or less pointed at posterior extremity. Sarcocyte layer thick. Nucleus small, spherical, (44μ in diameter—deMagalhaes—) with from four to six karyosomes. Epimerite a simple hyaline knob.

Cysts spherical or ovoidal. Spore ducts reach to outside of transparent cyst cover. Spore ducts 8 to 10 in number. Spores cylindrical to barrel shaped, truncate at ends, 8.5 by 3.7 and 4 by 8μ.

Taken at Danzig, Berlin, Heidelberg, Bonn, and Leipsic, at Paris, at Philadelphia, Pa. and at Rio Janeiro, Brazil. Hosts: *Periplaneta orientalis* (L.) *(Blattae or.); P. americana* (L.); *Blatella germanica* (L.) *(Ectobia germ.)*. Habitat: Intestine.

This is a remarkably cosmopolitan species, as seen from the locations where it was taken. It is remarkable also in that the name has remained almost undisputed since its discovery.

Leidy described briefly *Gregarina blattae orientalis* from the United States, which species proved to be synonymous with the earlier named species, coinciding in measurements, proportions and host.

Schneider gave a brief description, with good figures of an association and of a dehiscing cyst.

Bütschli admirably described the process of cyst formation from beginning to end, a process never before seen and very rarely described since.

Wolters observed some of the nuclear changes in the cyst.

Marshall contributed the third long paper on development.

deMagalhaes found the species in Brazil in 1900; three years later Crawley found it in the United States, both from the original host. The specimens found by these workers were undoubtedly those of the true old-world *G. blattarum.* The shape and proportions correspond, and in hosts of the nature of the cockroach, there is little wonder that both host and parasites are widely distributed.

GREGARINA LOCUSTAE Lankester

[Figure 188]

1853	*Gregarina Locustae Carolinae*	Leidy	1853 :239
1856	*Gregarina Locustae Carolinae*	Leidy	1856 :47
1859	*Gregarina fimbriata*	Diesing	1859 :730
1863	*Gregarina Locustae*	Lankester	1863 :94
1899	*Gregarina locustaecarolinae*	Labbé	1899 :35
1903	*Stephanophora locustaecarolinae*	Crawley	1903 :54
1907	*Gregarina locustaecarolinae*	Crawley	1907 :225
1913	*Gregarina locustaecarolinae*	Ellis	1913b :268

Gregarina: Sporonts biassociative. Maximum length of sporonts 350μ, average length 250μ. Ratio length protomerite : total length primite : : 1 : 6.8; width protomerite : width deutomerite : : 1 : 1.7. Protomerite a little more than hemispherical, one and one half times as wide as high. Deutomerite cylindrical, rather square cornered posteriorly, nearly twice as wide as the protomerite. Nucleaus large, spherical, with one karyosome. Epimerite a small rounded knob with a very short neck.

Taken at Philadelphia and Wyncote, Pa. Host: *Dissosteria carolina* (L.) Habitat: Intestine.

Crawley recognized (1907) the fact that Leidy described and illustrated two distinct species under the same name. Leidy's figures 35 and 36 (1853), the former my figure 188, represent isolated sporonts typical of the genus Gregarina in relative strength and width of protomerite and deutomerite. Associations were not mentioned, however. His figure 37 (Figure 189) is quite different in shape and the epimerite is an inverted campanular structure furnished with slender upwardly directed digitiform processes. Because of the epimerite, Crawley (1903) placed the species in the genus Stephanohora. In 1907, he found cephalonts in locusts quite unlike those seen by Leidy. They possessed simple knobbed epimerites like those of other species of the genus Gregarina. He saw the sporonts also, and they compared favorably in length with those described by Leidy. At the same time, Crawley substantiated Leidy's discovery of the digitform epimerite, for he found similar cephalonts and also sporonts which compared. Thus it was discovered that two species were involved, the one a true Gregarina, the other not. The latter species is now known as Actinocephalus fimbriatus (Diesing) Ellis.

The name of the species as given by Leidy is a trinominal and cannot stand. The first binominal name applied to the species was that of Lankester, which must be used to designate the species. The name used by Diesing, *Gregarina fimbriata,* applies to the species *Actinocephalus pachydermus* for he says proboscis ''digitato-fimbriata''.

GREGARINA OVICEPS Diesing

[Figures 191, 192]

1853	*Gregarina Achetae abbreviatae*	Leidy	1853:238
1856	*Gregarina Achetae abbreviatae*	Leidy	1856:47
1859	*Gregarina oviceps*	Diesing	1859:730
1863	*Gregarina Achetae*	Lankester	1863:94
1899	*Gregarina achetaeabbreviatae*	Labbé	1899:35
1903	*Gregarina achetaeabbreviatae*	Crawley	1903:45
1903	*Gregarina achetaeabbreviatae*	Crawley	1903a:639
1907	*Gregarina achetaeabbreviatae*	Crawley	1907:220-1
1913	*Gregarina achetaeabbreviatae*	Ellis	1913b:266
1915	*Gregarina achetaeabbreviatae*	Watson	1915:34

Gregarina: Sporonts biassociative, obese. Maximum length 500μ. Average sporonts 450μ in length, 225μ in width. Ratio length protomerite : total length primite :: 1 : 3; width protomerite : width deutomerite :: 1 : 1.1. Protomerite hemispherical to subglobose, width twice the height. Slight constriction at septum. Deutomerite stout-bodied, nearly as wide as long. Widest at shoulder where it is very little wider than protomerite. Posterior end truncate. Epimerite undescribed. Endocyte dense in deutomerite, less so in protomerite. Nucleus not visible in vivo and not seen. Cysts spherical, 250μ in average diameter. Spore ducts 2 to 5, of maximum length 1000μ. Spore barrels shaped, 4.5 by 2.25μ.

Taken at Haverford and Philadelphia, Pa., Beach Haven, N. J., Douglas Lake, Mich., Urbana, Ill., Oyster Bay, L. I. Hosts: *Gryllus abbreviatus* Serv. *(Acheta abbreviata); G. americanus* Blatch. Habitat: Intestine.

Leidy's drawing of the species (1853), my figure 191, represents the same gregarine as that described by later writers. But later drawings from Leidy's unpublished manuscript, Crawley's 1903 paper (Pl. III, Figs. 34, 35), show two distinctly different species, one associative and the other not. Crawley confused the two in his description, under the name *Gregarina achetaeabbreviatae.* In 1907 he described two distinct species, however, one the *Gregarina achetaeabbreviatae* of Leidy and a new *Stenophora erratica,* for the solitary species. The latter I have transferred to a new genus Leidyana. For description, see under *L. erratica.*

Ellis found this species at Douglas Lake, Mich., and I have found it from material taken at Haverford, Pa., Urbana, Ill., and Oyster Bay, L. I.

Diesing changed the name of Leidy's species to *Gregarina oviceps* without giving explanation therefor and since this is the oldest binomial name used, the species must bear this name.

GREGARINA MACROCEPHALA (Schneider) Labbé

1875	*Clepsidrina macrocephala*	Schneider	1875 :674
1882	*Clepsidrina macrocephala*	Schneider	1882 :442
1887	*Clepsidrina macrocephala*	Schneider	1887 :73
1895	*Clepsidrina* sp.	Cuénot	1895 :321
1897	*Clepsidrina gryllorum*	Cuénot	1897 :54
1899	*Gregarina macrocephala*	Labbé	1899 :10

Gregarina: Sporonts biassociative.

The following synopsis refers to the cephalont only, there being no available description of the sporont.

Ratio length protomerite : total length primite :: 1 : 5; width protomerite : width deutomerite :: 1 : 1.2. Protomerite rounded laterally, as wide as high. Constriction at septum. Epimerite superimposed upon protomerite on a short stout neck. Epimerite a large hyaline ovoidal body a little longer than the protomerite of the cephalont. Deutomerite elongate cylindrical, tapering suddenly to a sharp point. Endocyte with large irregularly arranged protoplasmic granules. Cysts spherical, dehiscing by spore ducts. Spores doliform.

Taken in Aisne, Indre-et-Loire, and Vienne, France. Hosts: *Nemobius sylvestris* (F.) *(Gryllus s.); Gryllus domesticus* L. Habitat: Intestine.

In 1875 Schneider merely mentioned the character of the epimerite of the undescribed species. In 1882 he described the cephalont only.

This species may be identical with *Gregarina oblonga* Dufour, from the same host. It is impossible, however, to correlate the two species for the reason that Dufour described only sporonts and Schneider only cephalonts.

Leidyana gryllorum (Clepsidrina g.) was erroneously included with this species by Labbé. For discussion, see under *L. gryllorum.*

GREGARINA PANCHLORAE Frenzel

[Figure 187]

1892	*Gregarina panchlorae*	Frenzel	1892:290-300

Gregarina: Sporonts biassociative, long and slender. Sporonts 180μ long, 35μ wide. Protomerite of satellite cylindrical, constricted slightly in anterior half. Deutomerite of primite fits into a deep depression in anterior end. Deutomerite cylindrical. Nucleus spherical, 18 to 20μ in diameter, with one karyosome.

Taken in Cordoba, Argentina. Host: *Panchlora exoleta* Klug. Habitat: Intestine.

Frenzel gave a meagre description and but one drawing of this species, illustrating only the manner in which the protomerite of the satellite fits into the deutomerite of the primite. This part of the association is intermediate between that of the same portion of *G. serpentula* deMagalhaes, as shown in his two figures, the one of a young, the other of a mature, association. (Figs. 185 and 186.) The lengths of the two species are, however, widely at variance so the species are not identical.

GREGARINA ACRIDIORUM Léger

1893	*Clepsidrina acridiorum*	Léger	1893:811-13
1896	*Clepsidrina acridiorum*	Léger	1896:27-30
1899	*Gregarina acridiorum*	Labbé	1899:10

Gregarina: Sporonts biassociative, cylindrical. Maximum length of individual 1000μ; minimum length 400μ, width 160μ. Ratio length protomerite : total length :: 1 : 5; protomerite subglobular in primite, depressed at anterior end in satellite. Deutomerite cylindrical, rounded at posterior end. Sarcocyte thick, especially in protomerite near septum. Endocyte yellow orange. Epicyte longitudinally striated. Myocyte well developed. Nucleus spherical, with many small karyosomes. Epimerite a simple spherical hyaline button on a short stalk.

Cysts spherical, 500μ in diameter. Spore ducts 12 to 15 in number, very long, yellow orange at base. Spores extruded in long chains. Spores doliform, 7.6 by 3.3μ.

Taken at Nemours, Algeria, and in Provence, France. Hosts: Various Acrididae, especially *Tryxalis* sp. *(Truxalis)*, *Pamphagus* sp. and *Sphingonotus* sp. Habitat: Intestine.

GREGARINA PARANENSIS (Kunckel d'Hercularis) Watson

1899	*Clepsidrina paranensis*	Kunckel d'Hercularis	1899:622
1916	*Gregarina paranensis*	Watson	(This paper)

Gregarina: Sporonts biassociative. Length not given. Deutomerite four times as long as protomerite. Ellipsoidal, pale yellow.

The author says the species differs from *G. acridiorum* Léger in having the deutomerite ellipsoidal instead of cylindrical, and the endocyte pale yellow instead of yellowish red. He says between the moults of the insect the parasites are abundant. They diminish in number after each moult.

Taken at Parana, Argentina. Host: *Schistocerca paranensis.* Habitat: Intestine.

GREGARINA SERPENTULA deMagalhaes

[Figures 185, 186]

1900	*Gregarina serpentula*	deMagalhaes	1900:140-44

Gregarina: Sporonts biassociative, slender, elongate. Maximum length association 1200μ, width 180μ. Average length 800μ, width 60μ.

The protomerite is 50μ long. Ratio length protomerite : total length :: 1 : 8; width protomerite : width deutomerite :: 1 : 1.3. Protomerite subspherical, flattened at septum, width equal to length. Constriction at septum. Deutomerite elongate cylindrical broadly rounded behind. Nucleus spherical with several karyosomes. Young associations more slender, protomerites greatly attenuated. Cysts spherical or ovoidal.

Taken at Rio Janeiro, Brazil. Host: *Periplaneta orientalis* (L.). Habitat: Intestine and coelom.

de Magalhaes names the species *serpentula* from the manner of movement.

> "– a m'ont paru rappeler la forme de la tête d'un serpent et ses mouvements."

The author found instances in which more than two sporonts were attached:

> "Celli-ci (espèce) fournit fréquement des examples d'association de plusieurs invidis disposes en file; deux trois et plus sont accolés par leurs extrémités opposées. D'autres fois, ils forment des groupes constitues d'un plus gros exemplaire, à l'extrémité postérieure duquel sont accolés deux, trois, cinq satellites plus petits."

These phenomena are observed in rare instances throughout the genus Gregarina.

This species is quite distinct in characteristics from *G. blattarum* Sieb., from the same host and its authenticity is not questioned.

GREGARINA RIGIDA (Hall) Ellis

[Figures 194, 197, 198, 271, 290-333, 336-338]

1907	*Hirmocystis rigida*	Hall	1907 :149-174
1907	*Gregarina melanopli*	Crawley	1907 :223
1913	*Gregarina rigida*	Ellis	1913b :267
1913	*Gregarina melanopli*	Ellis	1913c :82-3
1915	*Gregarina rigida*	Watson	1915 :34-35

Gregarina: Sporonts biassociative, rather stout bodied. Maximum length of association 1425μ, average length 550μ. Sporonts 250 to 750μ long, 130 to 210μ wide. Ratio length protomerite : total length :: 1 : 3 to 1 : 6 (primite); length protomerite : total length (satellite :: 1 : 5 to 1 : 16; width protomerite : width deutomerite :: 1 : 1.4. Protomerite somewhat flattened, width sometimes three times the height, generally less. Constriction at septum more or less indistinct. Deutomerite cylindrical or barrel shaped, little wider than protomerite, ending in a broadly rounded or flattened square cornered extremity.

Endocyte very dense and brownish yellow in deutomerite, tan in protomerite. Epimerite a small spherical hyaline knob.

Cysts yellow orange, 300μ in average diameter, spore ducts short, ten or more in number. Spores extruded in chains, barrel shaped, 5 by 8μ.

Taken at Wyncote, Pa.; Douglas Lake, Mich.; Lincoln, Neb.; Colorado Springs, Colo.; Boulder, Colo.; Urbana, Ill.; and Oyster Bay, L. I.

Hosts *Melanoplus femoratus* (Burm.); *M. luridis* (Dodge); *M. femur-rubrum* (de Geer); *M. atlantis* (Riley) *(M. atlantis); M. differentialis* (Uhler); *M. coloradensis* ? ; *M. angustipennis* (Dodge); *Encoptolophus sordidis* (Burm.); *Schistocerca americana* Burm.; *M. bivitattus* (Say); *Hesperotettix pratensis* Scudder; *Brachystola magna* Giard. Location: Intestine and caeca.

This species was first described by Hall as *Hirmocystis rigida.* He mentioned dehiscence of the cysts by simple rupture, and he saw neither the spores nor the epimerite. The only character in common with the genus Hirmocystis was the simple rupture of the cysts, and this character is possessed by some thirty genera.

Crawley (1907) published an article two months later describing a new species, *Gregarina melanopli,* which proved to be the same species. He found that dehiscence occurred by means of numerous spore ducts. The epimerite was still unknown.

Ellis changed the name of the species to *Gregarina rigida* (Hall).

I have taken parasites of this species from various Acrididae in material from Colorado Springs, Lincoln, and Urbana. In three instances specimens were recovered from *M. femur-rubrum* at Oyster Bay, L. I. (Fig. 271). Although hundreds of grasshoppers have been examined at the latter place, infection has been found but these few times, and then very few parasites were present. Cysts have developed, all with numerous long spore ducts. Typical spores were extruded.

GREGARINA KINGI Crawley

[Figure 193]

1907	*Gregarina kingi*	Crawley	1907:221-3
1913	*Gigaductus kingi*	Ellis	1913b:271

Gregarina: Sporonts biassociative, rather stout bodied. Maximum length of associations 350μ. Sporont measurements not given. Ratio length protomerite : total length :: 1 : 3; width protomerite : width deutomerite :: 1 : 1. Protomerite saddle-shaped, i.e. broadly dilated and nearly flattened apically, with deep constriction just below middle, dilated again less extremely below. Widest part twice the width of narrowest part. Protomerite equal in length to its greatest width, a slight constriction at septum. Deutomerite widening out rapidly from septum to shoulder, and quite regularly cylindrical from thence downward. Very broadly rounded at distal end. Nucleus spherical, small. Endocyte not dense.

Cysts spherical, 110μ in maximum diameter, one spore duct only, spores barrel shaped, 5 by 2.75μ in dimensions.

Taken at Wyncote, Pa. Host: *Gryllus abbreviatus* Serv. Habitat: Intestine.

Ellis placed the species in question in the genus Gigaductus, originally created by Crawley himself for *Gigaductus parvus.* I have allowed this genus to drop out, removing the type species to the genus Gregarina, for its differentiating character was the large single spore duct. A discussion of the matter is found in the chapter on Coleoptera, under the species *Gregarina parva.*

This species has been replaced in the genus to which it was originally assigned.

GREGARINA LONGIDUCTA Ellis

[Figure 195]

1913	*Gregarina longiducta*	Ellis	1913c:78-82

Gregarina: Sporonts biassociative, obese. Length of associations 800 to 900μ. Ratio length protomerite : total length primite :: 1 : 3.5; width protomerite : width deutomerite :: 1 : 1. Protomerite broadly rounded in front, widest through middle, twice as wide as high, and deeply constricted at septum. Deutomerite slightly broader than high, barrel shaped, widest through middle. Very broadly rounded or flattened at posterior end. Satellite longer than primite in all associations observed. Nucleus not seen. Endocyte very dense, black. Epimerite a short digitiform process equal in length to protomerite of cephalont.

Cysts spherical, 560μ in average diameter. Spore ducts 3 to 3.5 mm. in length, four in number, arranged around one pole of cyst. Spores discharged in chains. Cylindrical, 3 by 6.5μ.

Taken at Douglas Lake, Mich. Hosts: *Ceuthophilus latens* Scudder and *C. maculatus* (Say). Habitat: Intestine.

GREGARINA CONSOBRINA Ellis

[Figure 196]

1913	*Gregarina consobrina*	Ellis	1913b:267

Gregarina: Sporonts biassociative, obese. Average length of sporonts 600μ, average width 450μ. Ratio length protomerite : total length primite :: 1 : 3.5 to 1 : 4; width protomerite : width deutomerite :: 1 : 1.5. Protomerite hemispherical, no constriction at septum. Deutomerite subspherical to ovoidal, nearly or quite as wide as long, broadly rounded posteriorly. Endocyte not described. Nucleus not seen. Epimerite short, simple, digitiform.

Cysts 250 to 300μ in diameter. Spore ducts 4 to 6, all in one hemisphere, 900 to 1200μ in length. Spores extruded in chains, cylindrical, 3.2 by 8μ.

Taken at Boulder, Colo. Host: *Ceuthophilus valgas* Scudder. Habitat: Intestine.

GREGARINA ILLINENSIS Watson

[Figure 207]

1915	*Gregarina illinensis*	Watson	1915:34

Host: *Ischnoptera pennsylvanica* (de Geer).

This species was taken at Urbana, Ill., in November, 1914. The intestine of one field cockroach was found to contain twenty-five associations. A dozen or more immature specimens of the insect were collected at various times throughout the fall but only the one was infected.

The sporonts are biassociative and elongate cylindrical in shape. The maximum length of an association seen was 1110μ, length of the primite being 550μ, its width 180μ. Ratio length protomerite : total length primite :: 1 : 5; width protomerite : width deutomerite :: 1 : 1.1 to 1 : 1.5. The protomerite of the primite is dome shaped, the width equalling the height. The widest part of the primite is the middle portion. There is a constriction, not very deep, at the septum. The protomerite of the satellite is rectangular in shape, 1.5 times as wide as high and depressed at the anterior end into which concavity the primite fits. The deutomerite is regularly cylindrical, elongate and well rounded at the posterior end. The nucleus is large and spherical, and contains many small chromidia. The endocyte is dense in both protomerite and deutomerite and is black in transmitted light. The nucleus is not visible in vivo.

Cephalonts and cysts were not recovered from the host.

A table of measurements in which all dimensions are given in microns follows:

Total length association	1110	1110	1080	1050
Primite				
Length protomerite	100	100	100	90
Length deutomerite	450	450	440	410
Width protomerite	130	130	110	110
Width deutomerite	170	180	180	170
Total length sporont	550	550	540	500
Ratio				
length protom.: total length sporont	1:5.5	1:5.5	1:5.4	1:5.5
width protom.: width deutomerite	1:1.3	1:1.4	1:1.7	1:1.5
Satellite				
Length protomerite	70	130	80	70
Length deutomerite	530	430	440	480
Width protomerite	130	130	130	120
Width deutomerite	190	210	170	180
Total length sporont	560	560	520	550
Ratio				
length protom.: total length sporont	1:8	1:4.3	1:6.5	1:8
width protom.: width deutomerite	1:1.5	1:1.6	1:1.3	1:1.5

This species and the Old World *Gregarina blattarum* Sieb. of *Blatta orientalis* are differentiated as follows:

	G. blattarum	*G. illinensis*
Shape	Irregularly cylindrical	Very regularly cylindrical
Posterior end satellite	Not well rounded, often pointed	Well rounded always
Sarcocyte	Very thick	Thin except in protomerite
Shape protomerite of satellite	Flattened, wider at base than elsewhere 1.7 times as wide as at top, 2.5 times as wide as high	But slightly flattened, as wide at base as at top, 1.5 times as wide as high

In the following characteristics, the two species agree:

Ratio		
length protom.: total length primite	1: 5	1: 5
length protom.: total length satellite	1: 8	1: 8
Shape protomerite of primite	Hemispherical	Hemispherical
Nucleus	Spherical	Spherical

On the strength of the shape of the posterior end of the body, the shape of the satellite, and in the regularity in shape of the body there is basis for the creation of a new species, although in one important factor, proportions, the two species agree. There are no measurements stated for the Old World species. Schneider says ''– – elle devient trés-volumineuse'' which indicates that the species may be as large as the one here described. The species described by Leidy (1853:239) from *Blatta orientalis* agrees in size with both species. His drawings indicate an irregularly shaped body and a more or less sharply pointed posterior extremity and the hosts he dissected were probably the introduced European cockroach and the gregarine the Old World *G. blattarum.*

Crawley records (1903:44) the species *G. blattarum* as

> "Common in *Periplaneta orientalis, P. americana* and *Ectobia (Blatta) germanica.* A few specimens of *Ischnoptera pennsylvanica,* the field cockroach, were examined, but none contained gregarines."

These hosts undoubtedly yielded the same parasites which Leidy also had found at Philadelphia.

Ellis (1913b:83) says:

> "This gregarine was found in several specimens of the native roach *Ischnoptera pennsylvanica* from the woods near Douglas Lake. – – Although no introduced roaches have been collected in the vicinity – –, this gregarine from native roaches seemes undoubted the typical *G. blattarum,* agreeing in spores, cysts and sporonts with that species. The biological question of interest is, of course, the source of infection of these native roaches. – – It is possible, however, that *G. blattarum* is established in the native roaches in the new world. – – – both Frenzel and Magalhaes found the native roaches to be infected with gregarines other than *G. blattarum* – – –."

In his Syllabus (1913b:265), Ellis gives measurements which coincide fairly well with those recorded above in the table. The maximum length of a sporont he states to be 520μ, while that of the above species is 560μ. He says

> "Cysts prolate spheroids, average 450 x 900μ – –, spore ducts 10 or more, reaching the length of 200μ; sporocysts barrel-shaped, 4 x 8μ,"

Ellis' drawing differs somewhat in shape from that of any specimen seen by the present writer (ratio length protomerite : total length primite in the former 1 : 3.3, in the latter 1 : 5) but this is not sufficient to constitute a new species as it is the only difference in the two. It is highly probable that but one species is involved. Ellis' specimens were taken from *Ischnoptera pennsylvanica* (de Geer) at Douglas Lake, Mich.

Hall (1907) makes the simple statement that *Periplaneta americana* contains *Gregarina blattarum*. I have no reason to doubt its presence.

It is to be noted that the terms *Blatta orientalis* and *Periplaneta o.* are used interchangeably by various authors, the name now accepted being *Blatta orientalis* L.

GREGARINA GALLIVERI Watson

[Figures 205, 275-290]

1915	*Gregarina galliveri*	Watson	1915:33-34

Host: *Gryllus abbreviatus* Serv.

This species was taken at Oyster Bay, Long Island, in August, 1914. The parasite lives in the intestine of the host. The species is rare, being seen only three times in a hundred or more crickets opened, sixty-five associations and five cysts being found in a single host, and a dozen or more associations in each of the other two. In the first named, nearly all the associations were engaged in cyst making.

The sporonts are biassociative, even to the smallest seen. The maximum length of an association seen was 590μ, the maximum width 180μ. The animals are quite polymorphic but certain generalizations can be made. The protomerite of the primite is always wider than the deutomerite. Measurements indicate that it is but little wider, but the difference seems much greater because the two places of greatest width, those used in the table of measurements, are widely separated. The protomerite is low and broad, either flat or very slightly rounded at the anterior end and from two to four times as wide as high, the average being three. Its widest part is in the middle, where it is approximately one and a half times as wide as the septum. The protomerite of the satellite is considerably narrower than that of the primite. It is greatly flattened and from two to four times as wide as high. The deutomerite of the primite is constricted a little just below the septum, widening out below the middle where it attains nearly the measured width of the protomerite. In some instances it is nearly cylindrical. The deutomerite of the satellite is irregularly subglobular to broadly ellipsoidal in shape and is of approximately the same width as the protomerite of the primite. The ratio of length protomerite : total length primite (for twelve associations) remains nearly constant and is approximately the same in the satellite as in the primite, being 1 : 5. The ratio of width protomerite : width deutomerite of primite is approximately 1.5 : 1; in the satellite it is 1 : 1.4.

The endocyte is very dense in both protomerite and deutomerite, and is brown in color, not black as in so many species. The protomerite granules are much larger than those in the other species seen in the same host. The nucleus is small and spherical. It is not visible in vivo except in young individuals.

Upon carefully flattening out the association on the slide, by slight pressure, a large inflated papilla is seen on the anterior end of the satellite, which fits into a corresponding depression in the primite and makes the union firmer. This was well demonstrated in some specimens from a starved host in which the protoplasm of the parasite was pale tan throughout and both the papilla and the nuclei were clearly visible.

The trophozoites possess a knob shaped hyaline epimerite.

Cysts are 300 to 350μ in diameter*, very dense like the sporonts and deep brown in color. In one cricket, all the associations were engaged in cyst making. Two such processes were watched from the incipiency to the completion of the two cysts, and the process took place in less than half an hour. At 11 a. m., five cysts were present on another slide, and at 2 p. m. there were seven. Several of the cysts which when first observed were sporonts, developed to completion with the extrusion of ripe spores. The maximum number of spore ducts seen on a cyst was nine. The ducts are very long. The spores are barrel shaped, 3 by 6μ.

It was anticipated that this species was identical with Crawley's *Gregarina kingi* because of the peculiarly shaped protomerite of that species, but such was found not to be the case; the two species differ in many respects. The following table indicates the chief differences:

---

*The diameter, exclusive of the transparent layer, is 50μ less.

	G. galliveri	*G. kingi*
Maximum length of association	590μ	350μ
Ratio		
length protom.: total length sporont	1 : 5	1 : 3
width protom.: width deutomerite	1 : 0.8	1 : 1.1
Shape protomerite of primite	Broad and flat, shape slightly irregular three times as wide as high Wider than deutomerite	"Saddle shaped, broad and swollen in front, much narrower behind" Narrower than deutomerite
Shape protomerite of satellite	Flattened, four times as wide as high	"Subspherical to compressed", twice as wide as high
Shape deutomerite of primite	Constricted below septum, dilated below and widest in posterior two-thirds	"Cylindrical, generally broader in front. Outline often irregular"
Shape deutomerite of satellite	Subspherical to broadly ovate	
Nucleus	Spherical, small	Spherical, small
Endocyte	Very dense, deep brown in both protomerite and deutomerite	"Not dense"
Anterior surface of satellite	Provided with a very large, flattened papilla which fits into large depression in primite	Shows a slightly raised ring, primite fitting into a very shallow saucer on anterior end of satellite
Cysts, diameter	350μ	90 to 100μ.
Dehiscence	Many spore ducts	Single long spore duct
Frequency	Rare, not more than one cricket in 40 harboring it	"25% of crickets opened contained these parasites in countless numbers"

No other allied species has been described from crickets.

Measurements of a few associations with all dimensions expressed in microns are as follows:

Total length association	590	570	540	490	440
Primite:					
Length protomerite	60	70	60	60	40
Length deutomerite	230	200	210	210	190
Width protomerite	150	140	170	180	120
Width deutomerite	130	140	150	150	100
Total length sporont	290	270	270	270	230
Ratio					
length protom.: total length	1:5	1:4	1:4.5	1:4.5	1:5.7
width protom.: width deutomerite	1:1.1	1:1	1:1.1	1:1	1:4.1
Satellite:					
Length protomerite	50	50	50	40	50
Length deutomerite	250	250	220	180	170
Width protomerite	110	130	140	120	90
Width deutomerite	150	180	180	170	120
Total length sporont	300	300	270	220	210
Ratio					
length protom.: total length	1:6	1:6	1:5.4	1:5.5	1:4.2
width protom.: width deutomerite	1:1.3	1:1.4	1:1.3	1:1.4	1:1.3
Diameter cysts	350	300	350		

GREGARINA STYGIA Watson

[Figure 206]

1915	*Gregarina stygia*	Watson	1915:33

This new species was taken from *Ceuthophilus stygius* (Scudder), hosts found in an unused cistern on Dr. C. B. Davenport's grounds, at Cold Spring Harbor, L. I.

The infection was heavy, as many as five hundred parasites being found in each of several hosts, and each of the twelve examined contained at least a few parasites. The region of infection is the intestine.

The sporonts are biassociative as adults. The longest association measured 360μ. The sporonts are barrel shaped, the maximum length recorded being 180μ and the maximum width 100μ. The protomerite is nearly hemispherical in the primite and is flattened in the satellite. The deutomerite is widest at or in front of the middle portion. The satellite is somewhat more slender than the primite and is of the same length or a little shorter. The endocyte is dark tan in color, not very dense in either deutomerite or protomerite, and the nucleus is easily visible in vivo. The sarcocyte is thicker at the septum and anterior ends of the protomerite than elsewhere, but is fairly thick throughout. The nucleus is small and spherical and contains one or more large karyosomes.

Sections show that the cephalont possesses a single knobbed epimerite, slightly stalked. The sporozoite is spindle-shaped and contains a large nucleus. Several sporozoites were seen in the sectioned intestine lying free in the lumen or contiguous to the epithelial wall.

Movement is sluggish and of the ordinary two types, gliding and contortion.

Cysts average 150μ in diameter. Dehiscence was not seen.

This species is not identical with *Gregarina longiducta* Ellis (1913a:78-82), from *Ceuthophilus latens* and *C. maculatus.* Associations of the latter average 800 – 900μ in length, the smallest observed being 465μ long. Large associations of *G. stygia* are only 350μ in length. Proportions vary as well as lengths.

The species differs from *G. consobrina* Ellis (1913:267) in size. Sporonts of the latter species attain a length of 600μ, those of *G. stygia* not becoming longer than 180μ.

Satellite:

No other species is recorded from the genus Ceuthophilus.

A table of measurements is appended herewith, all dimensions being given in microns:

Total length associations	360	330	300
Primite:			
Length protomerite	30	20	30
Length deutomerite	150	140	120
Width protomerite	60	40	55
Width deutomerite	100	100	80
Total length sporont	180	160	150
Ratio			
length protom.: total length	1:6	1:8	1:5
width protom.: width deutomerite	1:1.6	1:2.5	1:1.5
Satellite:			
Length protomerite	20	25	30
Length deutomerite	160	145	120
Width protomerite	60	50	70
Width deutomerite	80	60	80
Total length sporont	180	170	150
Ratio			
length protom.: total length	1:9	1:7	1:5
width protom.: width deutomerite	1:1.3	1:1.2	1:1.1

GREGARINA NIGRA Watson

[Figures 210, 333, 334, 335]

1915 *Gregarina nigra*	Watson	1915:33

Hosts: *Melanoplus femur-rubrum* (deGeer); *Encoptolophus sordidus* (Burm.).

This parasite seems to be present only as a secondary one. It never occurs in large numbers but is generally found in the same host as *Gregarina rigida.* During the season of 1913, I found the parasite comparatively frequently, but not over half a dozen Acridiidae yielded the species when collections were made in the fall of 1914. It is easily differentiated from the more commonly found species in both color and shape, especially of the protomerite. It was collected only at Urbana, Illinois.

The maximum length of an association found was 1 mm. The ratios of various parts of the body are about the same as for *G. rigida.* The shape of the body is, however, quite different. The protomerite is shaped like a truncated cone; it is widest at the base, flattened on the top and square cornered. It is approximately as high as wide at the base; there is no constriction or only a very slight one at the septum. A slight indentation persists at the apex of the protomerite left by the detachment of the knob-like epimerite. The deutomerite is cylindrical, of the same width throughout and very little wider than the protomerite. It terminates in a broadly rounded extremity. The protomerite of the satellite is often not at all flattened but is little shorter than that of the primite and of approximately the same shape.

The endocyte of the deutomerite is very opaque and dense, being black in transmitted light. The protomerite is somewhat less dense than the deutomerite. The nucleus is not visible in vivo. It is spherical, in diameter about one third the width of the deutomerite and contains many karyosomes. The epicyte is thick at the anterior end of the protomerite, being thin elsewhere.

I have not been able to differentiate the cysts of this species (if present in my collections) from those of *G. rigida.* The size would be about the same, judging from the size of the associations. I have never seen an infection in which this species alone was present so have no way of knowing exactly which species yielded the cysts found when both species are present in an infection. In the instance of every cyst from Acridiidae which I have watched develop, spore ducts grew from small orange colored discs on the surface. The spore ducts were always short and the spores doliform.

A table of measurements follows in which all dimensions are given in microns:

Total length association	990	880	1000
Primite:			
Length protomerite	140	150	150
Length deutomerite	390	290	380
Width protomerite	120	130	140
Width deutomerite	150	170	180
Total length sporont	530	440	530
Ratio			
length protom.: total length	1:3.8	1:3	1:3.5
width protom.: width deutomerite	1:1.2	1:1.4	1:1.3
Satellite:			
Length protomerite	110	100	90
Length deutomerite	350	340	380
Width protomerite	110	120	130
Width deutomerite	170	150	160
Total length sporont	460	440	470
Ratio			
length protom.: total length	1:4.2	1:4.4	1:5.2
width protom.: width deutomerite	1:1.5	1:1.2	1:1.2

GREGARINA UDEOPSYLLAE nov. spec.

[Figures 260, 261]

Host: Udeopsylla nigra (Locustidae). Location, Urbana, Ill.

Three specimens of this rare host were examined and all found to be moderately infected with an hitherto undescribed gregarine. The parasites lay in inert masses in the mid intestine.

The sporonts are biassociative and obese. The maximum observed length for an association was 600μ. The largest primite was 310μ long and 200μ wide. The average ratio of length protomerite : total length sporont was 1 : 5.2, and the ratio of width protomerite : width deutomerite : : 1 : 5. The sporont is elongate ellipsoidal in shape. The protomerite of the primite is slightly longer than wide, widest in the central portion, and terminates in a small cone. There is a deep constriction at the septum. The deutomerite is widest in the middle, and the satellite terminates in a broadly rounded extremity. The protomerite of the satellite is broad and shallow and from two to three times as wide as long. An indentation is present in the anterior end of each protomerite of an association.

The protoplasm is dense, tan in the protomerite and black in the deutomerite. The nucleus is spherical and is visible only in young specimens.

Cysts and the epimerite were not seen.

Some of the more important measurements, with all dimensions given in microns, follow:

Total length association	600	580	500
Primite:			
Length protomerite	60	50	50
Length deutomerite	250	220	200
Width protomerite	100	100	60
Width deutomerite	200	130	110
Length sporont	310	270	250
Ratio			
length protom.: total length	1:5.1	1:5.4	1:5
width protom.: width deutomerite	1:2	1:1.3	1:1.8
Satellite:			
Length protomerite	40	50	50
Length deutomerite	250	260	200
Width protomerite	140	100	80
Width deutomerite	190	120	110
Length sporont	290	310	250
Ratio			
length protom.: total length	1:7.2	1:6.2	1:5
width protom.: width deutomerite	1:1.3	1:1.2	1:1.3

This species differs from *Gregarina longiducta* Ellis in length of the sporonts and in shape of the protomerite; and from *G. consobrina* Ellis in shape and proportions of the protomerite; it differs from *G. stygia* Watson in size and shape.

The hosts from which all these gregarines are taken are various species of the genus Ceuthophilus, which is closely related to the genus Udeopsylla. The parasite in question is readily distinguished from the above species by the cone-shaped protomerite of the primite.

LEIDYANA ERRATICA (Crawley) Watson

[Figures 208, 218-56]

1903	*Gregarina achetaeabbreviatae*	Crawley	1903:45
1907	*Stenophora erratica*	Crawley	1907:221
1915	*Leidyana solitaria*	Watson	1915:35

Hosts: *Gryllus abbreviatus* Serv. and *G. pennsylvanicus* Burm.

The parasites were taken at Cold Spring Harbor and Oyster Bay, L. I., Haverford, Pa., and at Urbana, Illinois, during the summer and fall of 1914.

The intestine is the usual seat of infection, although the pyloric caeca are not infrequently found to contain parasites. The latter are generally present in small or moderate numbers, from 1 to 25 per host, and nearly ever cricket examined at this season was parasitized. Sometimes the number per host runs up to one hundred or more, but this is rare.

The parasites are solitary, never associative in the normal sporont life. The maximum recorded length is 500μ, the maximum width 160μ. The ratio of length protomerite to total length for fifteen specimens is 1:5 to 1:7. The ratio of width is 1 : 1.3 to 1 : 1.7. The protomerite is slightly wider than high. It is broadly cone-shaped, dilated in the middle and constricted at the septum. The constriction is very conspicuous and fairly deep in the adults. There is no papilla at the anterior end. The deutomerite is cylindrical to elongate ellipsoidal, sometimes tapering but always rounded at the end (Figures 218, 221).

The endocyte is very dense and black in the deutomerite (in transmitted light) and pale tan in the protomerite, the two parts being sharply contrasted. Longitudinal striations are easily discernible with the aid of an intra vitam stain or after crushing the body and releasing the dense endocyte (Figure 243). The nucleus is spherical and contains one or two small karyosomes. It is not visible in the dense adults, but is seen in vivo in the younger sporonts and in the trophozoites.

The epimerite is a large simple spherical hyaline knob set upon a short slender stalk (Figures 224, 227). The sarcocyte is very distinctly visible in contrast to the contiguous endocyte. It is thin and of even width throughout.

Trophozoites with epimerites are common, both free in the lumen and attached to the cells of the intestine. They are transparent or nearly so. Some individuals are surprisingly large.

Cysts average 350μ in over all diameter, the transparent envelope being about 30μ in thickness when the cyst is new. Dehiscence is by spore ducts from one to twelve or more in number. Spores are extruded from the long ducts in chains. The spores are barrel-shaped and measure 3 by 6μ.

This species was described by Crawley (1903:45) as *Gregarina achetaeabbreviatae* Leidy and later as *Stenophora erratica.* Crawley first considered the species identical with Leidy's *Gregarina achetaeabbreviatae* from the same host but later (1907:221) created for it a new species because

> "– – at the anterior tip of the protomerite the ectosarc is often thickened to form a low papilla, within which are traces of a pore."

It is this character which led him to place the gregarine in the genus Stenophora. He adds:

> "The suggestion is permissible that this form is actually the common *Stenophora julipusilli* Leidy, somewhat altered from being in the wrong host – – –".

The suggestion that the species belongs to the family Stenophoridae is excluded when one considers the method of cyst dehiscence, which is that characteristic of the family Gregarinidae rather than that of the Stenophoridae.

The sarcocyte at the anterior end of the protomerite is often thickened and papillate but I have not seen a trace of a pore.

A table of measurements follows, all dimensions being given in microns:

Length sporont	500	490	470	420	370	290
Length protomerite	80	70	80	60	60	50
Width protomerite	110	90	80	80	80	50
Width epimerite						30
Width deutomerite	150	150	160	140	130	60
Ratio						
length protom.: tl. length	1:6.3	1:7	1:6	1:7	1:6.1	1:6
width protom.: width deu.	1:1.3	1:1.7	1:2	1:1.7	1:1.6	1:1.2

LEIDYANA GRYLLORUM (Cuénot) Watson

[Figure 209]

1897	*Clepsidrina gryllorum*	Cuénot	1897:52-54
1900	*Gregarina macrocephala*	Labbé	1899:10
1901	*Gregarina gryllorum*	Cuénot	1901:594-5
1916	*Leidyana gryllorum*	Watson	(This paper)

Leidyana: Sporonts solitary, never associative, cylindrical. Length 420μ. Ratio length protomerite : total length :: 1 : 5; width protomerite : width deutomerite :: 1:1.1. Protomerite subspherical, a deep constriction at septum. Deutomerite cylindrical, conical at end. Epimerite globular, nucleus small, spherical. Cysts spherical or ovoidal, 190 to 240μ in diameter. Spore ducts 3 to 8μ. Spores barrel shaped, 7μ in longest axis.

Taken in Ardennes and Meurthe-et-Moselle, France. Host: *Gryllus domesticus* (L.). Habitat: Intestine.

Labbé placed this species which had been mentioned but not described by Cuénot as a synonym of *Gregarina macrocephala* Schn., which is only known from the cephalont. Cuénot (1901) says regarding the disposition of the species:

> "Labbé – – – l'à réunit de son propre chef à la *G. macrocephala* A. Schn.; or, cette derniere espèce est trop mal connue pour qu'il ait quelque à l'identifier à la mieune; le grand épimérite en forme de massue de 'macrocephala' n'est certainment pas pareil a celui de 'gryllorum.'

In a footnote he adds:

> "Schneider ne décrit pas la forme adulte et ne parle pas du nombre de sporeductes des kystes."

Therefore the species has an individuality. It is very similar to the species described here under the name *Leidyana erratica.* Both are solitary, size of the two is nearly the same, ratios of various parts not radically different and shape of the deutomerite quite similar. The cysts are slightly smaller than in the latter species, but they dehisce by approximately the same number of spore ducts and the spores are similar. The epimerites of the two species are spherical and large. The nuclei are spherical. The only difference seems to be in the shape of the protomerite. In all the hundreds of specimens I have seen of *L. erratica,* none has possessed a protomerite rounded at the anterior end; all have been decidedly conical at the apex. In the present species, the protomerite is broadly rounded—subspherical—in shape; the constriction at the septum is considerably deeper than in the other species. I have separated the two on the basis of this character alone, deeming it of sufficient import to differentiate the species. Both species are parasites of the genus Gryllus, but of different species. The host of the former, *Gryllus domesticus,* flourishes in the old world and is rare in the United States, having formerly been found about old log houses, the former occupants of which undoubtedly introduced it from Europe (Blatchley). The host of *Leidyana erratica, Gryllus abbreviatus,* is the common field cricket in the United States. The infection is unlikely to have spread from the one host to the other.

HYALOSPORA ROSCOVIANA Schneider

For detailed synopsis and discussion of this species, see the chapter on Coleopteran parasites, under the same species name. The host is *Petrobius maritimus,* but as the genus Petrobius has been described for both Coleoptera and Orthoptera, it is impossible to state finally whether the host was a beetle or an orthopteran, or a thysanuran.

HYALOSPORA AFFINIS Schneider

[Figure 200]

1882	*Hyalospora affinis*	Schneider	1882 :445-6
1899	*Hyalospora affinis*	Labbé	1899 :14

Hyalospora: Sporonts biassociative, slender and elongate. Length of cephalonts 300μ. Sporont measurements not given. Ratio length protomerite : total length primite :: 1 : 5 (without epimerite). Ratio width protomerite : width deutomerite :: 1 : 1.8. Endocyte yellow. Epimerite a hyaline knob, present on the primite of an association in the figure given (Fig. 201). Nucleus ellipsoidal, with one or two karyosomes.

Cysts spherical or subspherical, yellow in color, 60μ in diameter. Spores 8.7 by 6μ.

Taken at Roscoff, France. Host: *Machilus cylindrica* E. Geoff. Habitat: Intestine.

Schneider's figure is a paradox. It shows an association, the primite of which is a cephalont, with an epimerite. This condition is almost unique in the history of gregarines, for it is an unwritten law that only sporonts couple themselves together. I have, however, seen the phenomenon in one instance in the genus Gregarina.

GAMOCYSTIS TENAX Schneider

[Figure 201]

1875	*Gamocystis tenax*	Schneider	1875 :586-7
1899	*Gamocystis tenax*	Labbé	1899 :12
1913	*Gamocystis tenax*	Ellis	1913b :271

Gamocystis: Sporonts biassociative, in apposition, head to head; obese. No protomerite in the sporonts. Body ovoidal to subconical, posterior extremity rounded, nucleus spherical with one karyosome. Endocyte with large irregular granules. Cysts spherical, sporulation partial, spore ducts 15 or more in number, short, extending only into the thick transparent layer of the cyst. Spores elongate cylindrical, rounded at the ends.

Taken at Roscoff, France. Hosts: *Blattella lapponica (Ectobia lapponica* (L.) ; *Blatta lapponica).* Habitat: Intestine.

HIRMOCYSTIS GRYLLOTALPAE (Léger) Labbé

[Figure 211]

1892	*Eirmocystis gryllotalpae*	Léger	1892:112
1899	*Hirmocystis gryllotalpae*	Labbé	1899:13

Hirmocystis: Sporonts in associations of two or three. Length of sporonts 80 – 90μ. Protomerite subspherical. Cysts spherical, 60μ in diameter. Spores elongate ovoidal, 5 by 2.1μ.

Taken at Poitou, France. Host: *Gryllotalpa gryllotalpa* (L.) *(G. vulgaris)*. Habitat: Intestine.

Léger and Labbé include here, as a synonym, *Gregarina sphaerulosa* Dufour (1837:12), probably on the strength of the fact that the latter was found in the same host genus.

At the end of the chapter on Orthoptera will be found a statement that Dufour's *G. sphaerulosa* was described from cysts instead of from sporonts. Dufour did not know the mode of reproduction of the little animals he had discovered a few years previous and looked upon the white spherules as a new species. It is interesting to note that he discovered cysts from two unallied hosts and he found enough difference between the cysts to designate them as two separate species.

PILEOCEPHALUS BLABERAE (Frenzel) Labbé

[Figures 202, 203]

1892	*Gregarina blaberae*	Frenzel	1892:300-14
1899	*Pileocephalus blaberae*	Labbé	1899:20
1913	*Gregarina blaberae*	Ellis	1913b:266

Pileocephalus: Sporonts solitary, rather stout-bodied. Length of sporonts 500μ, width 150μ. Ratio length protomerite : total length sporont :: 1 : 5; width protomerite : width deutomerite : 1 1.6. Protomerite hemispherical to subglobular, 1.4 times as wide as high, very deeply constricted at septum. Deutomerite ovoidal, widest through central portion or just in front thereof, rounded at posterior end. Nucleus spherical, with one karyosome. Epimerite long, cordiform, dilated at base into a flattened sphere which is over half the width of the protomerite in its width. Epimerite equal in length to half the whole cephalont length (without the epimerite).

Cyst and spores not known.

Taken at Cordoba, Argentina. Hosts: *Blabera claraziana* Sauss. and related species. Habitat: Intestine.

Ellis replaced this species in the genus Gregarina although the only known diagnostic character, the epimerite, does not coincide with that of the genus. This structure does, however, agree in shape with that of the genus Pileocephalus according to Schneider (1875:591) and Labbé (1899:19): ''Épimérite régulier simple conoide ou en fer de lance'' and I have replaced it in the genus Pileocephalus.

ACTINOCEPHALUS FIMBRIATUS (Diesing) Watson

[Figures 189, 190]

1853	*Gregarina Locustae Carolinae*	Leidy	1853:239
1856	*Gregarina Locustae carolinae*	Leidy	1856:47
1859	*Gregarina fimbriata*	Diesing	1859:730
1903	*Stephanophora locustaecarolinae*	Crawley	1903:54
1907	*Stephanophora pachyderma*	Crawley	1907:226
1913	*Actinocephalus pachydermus*	Ellis	1913b:278
1916	*Actinocephalus fimbriatus*	Watson	(This paper)

Actinocephalus: Sporonts solitary, obovate. Maximum length of sporonts 500μ. Protomerite hemispherical, not constricted at septum but contour continuous with that of deutomerite. Latter tapers slightly, ending in a blunt point. Sarcocyte very thick, especially over anterior end of protomerite. Endocyte black in deutomerite, less dense in protomerite. Nucleus spherical with 12 or more small karyosomes. Epimerite an inverted campanula, sessile, with ten or more slender digitiform processes directed upward along the periphery.

Cysts and spores unknown.

Taken at Wyncote, Pa. Host: *Dissosteira carolina* (L.): Habitat: Intestine.

A cephalont of this species was first seen by Leidy in 1853. He described it and the sporonts of *Gregarina locustae carolinae* together under the latter name.

In 1903, Crawley renamed the species *Stephanophora locustaecarolinae* from the character of the epimerite, as drawn by Leidy. Crawley did not see the species then. The error of inclusion was discovered by Crawley from new material in 1907, and he then separated the two species, describing each in detail. The former he called *Stephanophora pachyderma,* the latter by the original name.

The first binomial name given to this species, however, was *Gregarina fimbriata,* which Diesing used. He redescribed *Gregarina locustae carolinae* of Leidy under a new name adding no new material. He says of this species ''proboscis digitato-fribriato'', which definitely places his description.

Ellis transferred the species in question to the genus Actinocephalus, where it belongs because of the character of the epimerite. The genus Stephanophora was distinguished by its flat cushion-like epimerite with stout broad digits rising from the periphery. The genus has now been merged with another and the name discontinued.

INDETERMINATE SPECIES

GREGARINA CONICA Dufour

[Figure 102]

1837	*Gregarina conica*	Dufour	1837 :12
1851	*Gregarina conica*	Diesing	1851 :8
1863	*Gregarina conica*	Lankester	1863 :95

Dufour's description is as follows:

> "Oblongo-conica; cephalothorace subgloboso abdominis tertiam partem adaequante. Hab. Coleopterorum et Gryllorum."

In 1826 Dufour described an intestinal parasite from Coleoptera. In 1828 he named it Conica; in 1837 he gave as hosts the above animals and named the parasite *Gregarina conica.* The parasite is illustrated in his 1837 paper. That he had two species under consideration is obvious from his drawings as seen in Figures 101 and 102, one being labelled as from Coleoptera and the other from Gryllus. The former has a crenulate, stalked epimerite, the latter a simple spherical stalked one. The former figure has been homologized with several drawings by subsequent writers and represented the parasite described in the chapter on Coleopteran parasites under the name of *Actinocephalus conicus* (Dufour) Stein.

Stein described a parasite, *Actinocephalus lucani,* from a beetle, which is identical with Dufour's drawing 7. He did not know of Dufour's paper and the previous discovery of the species, but Frantzius (1848 :195) did, and mentioned Stein's *Actinocephalus lucani* from Lucanus, leaving the original *Gregarina conica* Dufour from Gryllus only.

Diesing (1851) listed both *G. conica* Dufour from Coleoptera and Gryllus, and *G. Lucani* Stein from *Lucanus parallelopipedus.*

Lankester did likewise. After his citation, *G. conica* dropped out of the literature. It is obvious that Dufour found a parasite in Orthoptera, but what it was no one can say. He did not find associations and no one knows whether he saw only the isolated cephalonts with the epimerites, which he shows in his drawing, or whether he saw sporonts which were not associative.

So the generic position of the species is doubtful. The family determination is fairly definite, from the simple spherical epimerite, but the species must be relegated to the group of the indeterminate species.

GREGARINA DAVINI Léger and Duboscq

[Figure 204]

1899	*Gregarina Davini*	Léger and Duboscq 1899:xxxviii-xl

Gregarina: Sporonts not described, cephalonts alone known. Nucleus spherical, with a large irregularly shaped karyosome. Epimerite large and spherical, set upon a rather long stout collar formed by a projection of the anterior end of the protomerite.

Cysts spherical, with 12 or more long spore ducts from which spores are extruded in chains. Spores barrel shaped, 8μ long.

Taken at Marseilles, France. Host: *Gryllomorpha dalmatina* Ocsk. Habitat: Intestine and caecum.

Although sporonts have not been found, the species is undoubtedly a member of the genus Gregarina from the mode of dehiscence and the shape of the epimerite. It cannot be determined whether or not the species has been described elsewhere from the sporont in addition to these other factors under a different name. Until sporonts are found and correlated with the description herewith, the species must remain incomplete.

MISCELLANEOUS

GREGARINA SPHAERULOSA Dufour

[Figure 179]

1837	*Gregarina sphaerulosa*	Dufour	1837:12
1851	*Gregarina sphaerulosa*	Diesing	1851:11
1863	*Gregarina sphaerulosa*	Lankester	1863:94
1899	*Hirmocystis gryllotalpae*	Labbé	1899:13

Dufour described this form as follows:

> "Subspherica alba, cephalothorace abdomen adaequanta. Hab. in ventriculo Oedipodarum et Gryllotalpae.
>
> Elle–est – – – egàlant à peine la grosseur d'une tête de fine épingle a insectes; – – –. Les individus bien adultes semblent résulter de l'union de deux hémisphères. Des yeux peu rigoreux pourraient croire que ce sont deux individus accouplés bout à bout."

It is obvious from the description and from the figure that what Dufour saw and named were not sporonts but cysts formed by the union of two equal or sub-equal sporonts. None of his other descriptions of sporonts applies to the particular species of Orthoptera from which these cysts were taken, so no sporonts, but only cysts, must have been present in the host. Dufour did not, as might have been the case, describe the cysts and sporonts in the same host as separate species. These cysts were taken from *Oedipoda coerulescens* and from *Gryllotalpa* sp.

Neither Frantzius nor Lankester mentioned the 'species' and the host. Labbé mentioned it as a synonym of *Hirmocystis gryllotalpae* (Léger) Labbé, probably from an identity of host genera and certainly not because of any similarity in appearance.

GREGARINA SOROR Dufour

[Figure 180]

1837	*Gregarina soror*	Dufour	1837 :12
1851	*Gregarina soror*	Diesing	1851 :11
1863	*Gregarina soror*	Lankester	1863 :94
1899	*Gregarina soror*	Labbé	1899 :34

Just as in the instance above, Dufour has here described cysts instead of sporonts. His words are as follows:

> "Subsphericum alba, cephalothorace abdominis dimidiam partem adaequante."
>
> "Celle-ci n'est peut-être qu'une variété de la précédente; mais le cephalothorace ne forme pas, comme dans cetta dernière, la moite de tout le corps."

The cyst in question consists of two unequal parts, making the "cephalothora" less than half the sphere.

Diesing and Lankester mention the form and Labbé places it in his "Uncertain" group under the original name.

POLYCISTID GREGARINES IN THE COLEOPTERA*

NAME OF PARASITE	NAME OF HOST
DIDYMOPHYIDAE	
Didymophyes gigantea Stein	*Oryctes* sp. larva.
	Oryctes nasicornis (L.) larva.
	Phyllognathus sp. larva.
Didymophyes paradoxa Stein	*Geotrupes stercorarius* (L.)
Didymophyes leuckarti Marshall	*Aphodius prodromus* (Brahm.)
	Aphodius nitidulus F.
Didymophyes minuta (Ishii) Watson	*Tribolium ferrugineum* F.
ACTINOCEPHALIDAE	
Actinocephalus concius (Dufour) Frantzius	*Dorcus parallelopipedus* (L.)
Actinocephalus dytiscorum (Frantzius) Watson	*Dytiscus marginalis* L. larva.
Actinocephalus stelliformis Schneider	*Ocypus olens* Mull. larv. and ad.
	Carabus auratus L.
	C. violaceus L.
	Rhizotrogus sp. larva.
Actinocephalus digitatus Schneider	*Chlaenius vestitus* (Payk.)
Actinocephalus acutispora Léger	*Silpha laevigata* F.
Actinocephalus americanus Crawley	*Galerita bicolor* Drury
Actinocephalus harpali (Crawley)	*Harpalus caliginosus* Fab.
Actinocephalus dicaeli (Crawley) Ellis	*Dicaelus ovalis*
Actinocephalus crassus (Ellis)	*Leptochirus edax* Sharp
Actinocephalus zophus (Ellis)	*Nyctobates barbata* Knoch
	Alobates pennsylvanica deGeer
Actinocephalus gimbeli (Ellis) Watson	*Harpalus pennsylvanicus* Dej.
Asterophora philica (Leidy) Crawley	*Nyctobates pennsylvanica* deGeer
Asterophora cratoparis Crawley	*Cratoparis lunatus* Fab.
Beloides firmus (Léger) Labbé	*Dermestes lardarius* L. larva
Beloides tenuis (Léger) Labbé	*Dermestes undulatus* Brahm. larva
Bothriopsis histrio Schneider	*Colymbetes fuscus* L.
	Hydaticus cinereus L. larva
	Acilius sulcatus L.
	Dytiscus sp. larva

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*The species are arranged in families, the families include genera in alphabetical order, and under each genus the species are placed in chronological sequence.

Bothriopsis terpsichorella (Ellis) Watson	*Hydrophilus* sp.
Legeria agilis (Schneider) Labbé	*Colymbetes* sp. larva
Phialoides ornata (Léger) Labbé	*Hydrophilus piceus* (L.) larva
Pileocephalus bergi (Frenzel) Labbé	*Necrobia ruficollis* Fabr.
Pyxinia rubecula Hammerschmidt	*Dermestes lardarius* L. larva
	D. vulpinus F. adult
Pyxinia crystalligera Frenzel	*Dermestes vulpinus* Fabr. larva
	D. peruvianus Casteln. larva, ad.
Pyxinia frenzeli Laveran and Mesnil	*Attagenus pellio* L.
Pyxinia möbuszi Léger and Duboscq	*Anthrenus verbasci* Olivier, larva
Stictospora provincialis Léger	*Melolontha* sp. larva
	Rhizotrogus sp. larva
Steinina ovalis (Stein) Léger and Duboscq	*Tenebrio molitor* L. larva
Steinina obconica Ishii	*Tribolium ferrugineum* F.
Steinina rotunda Watson	*Amara angustata* Say
Steinina harpali Watson	*Harpalus pennsylvanicus longior* (Kirby)
Stylocystis ensifera (Ellis)	*Leptochirus edax* Sharp
STYLOCEPHALIDAE	
Cystocephalus algerianus Schneider	*Pimelia* sp.
Lophocephalus insignis (Schneider) Labbé	*Helops striatus* Geoff.
Oocephalus hispanus Schneider	*Morica* sp.
Stylocephalus oblongatus (Hammerschmidt) Watson	*Opatrum sabulosum* (L.)
	Asida grisea (F.)
Stylocephalus longicollis (Stein) Watson	*Blaps mortisaga* L.
Stylocephalus brevirostris (Kölliker) Watson	*Hydrophilus* sp. larva
Stylocephalus gladiator (Blanchard) Watson	*Helenophorus collaris* L.
Stylocephalus giganteus Ellis	*Eleodes* sp.
	Asida sp.
	Asida opaca Say
	Eusattus sp.
Sphaerorhynchus ophioides (Schneider) Labbé	*Acis* sp.

ACANTHOSPORIDAE

Acanthospora pileata Léger	*Omoplus* sp. larva *Cistelides* sp.
Acanthospora polymorpha Léger	*Hydrous caraboides* (L.) larva
Ancyrophora gracilis Léger	*Carabus* sp. larva and ad. *Carabus auratus* L. *Carabus violaceus* L. larva and ad. *Silpha thoracica* L. larva
Ancyrophora uncinata Léger	*Dytiscus* sp. *Colymbetes* sp. *Sericostoma* sp. *Limnophilus rhombicus* (L.)
Cometoides capitatus (Léger) Labbé	*Hydrous* sp. larva.
Cometoides crinitus (Léger) Labbe	*Hydrobius* sp. larva
Corycella armata Léger	*Gyrinus natator* (L.) larva

GREGARINIDAE

Hyalospora roscoviana Schneider	*Petrobius maritimus*
Sphaerocystis simplex Léger	*Cyphon pallidulus* Boh.
Euspora fallax Schneider	*Rhizotrogus aestivus* Oliv.
Hirmocystis asidae Léger	*Asida servillei* Sol.
Hirmocystis harpali Watson	*Harpalus pennsylvanicus erythropus* (Dej.)
Gregarina cuneata Stein	*Tenebrio molitor* L. larva and ad.
Gregarina polymorpha (Hammerschmidt) Stein	*Tenebrio molitor* L. larva and ad.
Gregarina amarae Frantzius	*Poecilus cupreus* (L.)
Gregarina tenuis Hammerschmidt	*Allecula* sp.
Gregarina elongata Frantzius	*Crypticus* sp.
Gregarina scarabaei Lankester	*Scarabaeus relictus* larva
Gregarina passali Lankester	*Passalus cornutus* Fab.
Gregarina melolonthae Lankester	*Melolontha brunnea*
Gregarina munieri (Schneider) Labbé	*Timarcha tenebricosa* (F.) *Chrysomela violacea* (Goeze) *C. haemoptera* L.
Gregarina laucournetensis (Schneider) Labbé	*Parnus* sp.
Gregarina statirae Frenzel	*Statira unicolor* Blanch.
Gregarina longirostris (Léger) Labbé	*Thanasimus formicarius* (L.)

Gregarina acuta (Léger) Labbé	*Trox perlatus* Scriba
Gregarina steini Berndt	*Tenebrio molitor* L. larva
Gregarina parva (Crawley) Watson	*Harpalus pennsylvanicus* Dej. *H. caliginosus* Fab.
Gregarina lucani (Crawley) Watson	*Lucanus dama* Thunb.
Gregarina cavalierina Blanchard	*Dendarus tristis* Rossi (=*coarcticollis* Mls.)
Gregarina socialis Léger	*Eryx ater* Fabr. larva
Gregarina guatemalensis Ellis	*Ninus interstitialis* Esch.
Gregarina grisea Ellis	*Tenebrio castaneus* Knoch
Gregarina minuta Ishii	*Tribolium ferrugineum* F.
Gregarina katherina Watson	*Coccinella novemnotata* Herbst.
Gregarina barbarara Watson	*Coccinella* sp.
Gregarina fragilis Watson	*Coccinella* sp.
Gregarina tenebrionella Watson	Tenebrionidae larva
Gregarina gracilis Watson	Elateridae larva
Gregarina intestinalis Watson	*Pterostichus stygicus* Say
Gregarina monarchia Watson	*Pterostichus stygicus* Say
Gregarina globosa Watson	*Coptotomus interrogatus* (Fab.)
Gregarina platyni Watson	*Platynus ruficollis* Marsh.

UNCERTAIN SPECIES IN GENUS GREGARINA

Gregarina elaterae Crawley	*Elater* sp. larva
Gregarina curvata (Frantzius) Diesing	*Cetonia aurata* larva

UNCERTAIN SPECIES IN UNCERTAIN FAMILIES

Gregarina boletophagi Crawley	*Boletophagus cornutus*
Gregarina microcephala Leidy	*Arrhenoplita bicornis* Olivier
Gregarina ovalis (Crawley) Watson	Cucujidae larva
Gregarina coptotomi Watson	*Coptotomus interrogatus* Fab.
Stylocephalus sp.	*Xylopinus saperdioides* Oliv.
Gregarina sp. Crawley	Host not given

DIDYMOPHYES GIGANTEA Stein

[Figures 61, 63]

1848	*Didymophyes gigantea*	Stein	1848:186
1863	*Gregarina gigantea*	Lankester	1863:95
1889	*Didymophyes gigantea*	Mingazzini	1889:234-9
1892	*Didymophyes gigantea*	Léger	1892:106

Didymophyes: Sporonts biassociative, slender, very much attenuated. Average length 1 cm., average width 80 to 100μ. Ratio length protomerite : total length primite :: 1 : 30 to 1 : 40; width protomerite : width deutomerite :: 1 : 0.66 to 1 : 1. Protomerite dome shaped with a short wide neck just anterior to septum. Deutomerites two in number, cylindrical, widest at septum and tapering gradually, ending in a blunt rounded extremity.* Septa convex upward. Deutomerites nearly equal in length. Nuclei not visible in vivo and not described. Endocyte dense, deeply staining. Epimerite a cylindrical-conical papilla.

Cysts spherical, 600 to 700μ in diameter. Spores ovoidal, two integuments, 6 by 6.5μ.

Taken at Berlin, Naples, and Poitiers. Hosts: Larvae of *Oryctes nasicornis* (L); of *Phyllognathus* sp. and of *Oryctes* sp. Habitat: Intestine.

DIDYMOPHYES PARADOXA Stein

[Figures 62, 72]

1848	*Didymophyes paradoxa*	Stein	1848:223
1863	*Gregarina paradoxa*	Lankester	1863:95
1892	*Didymophyes rara*	Léger	1892:106
1899	*Didymophyes paradoxa*	Labbé	1899:8

Didymophyes: Sporonts biassociative, short. Length and width not given. Ratio length protomerite : total length :: 1 : 7 to 1 : 9; width protomerite : width deutomerite :: 1 : 1 to 1.1 : 1. Protomerite dome shaped, considerably flattened, twice as wide as high, a little wider than deutomerite. First deutomerite cylindrical, of same length or 1½ times longer than second; second tapering to a blunt point. Septa convex upward. Nuclei visible, spherical and large, one in each deutomerite. Cyst and spores unknown.

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*Stein's figure indicates that the first deutomerite in its anterior third is narrower than at the first septum, becoming as wide at the septum between the two deutomerites as it is at the septum between protomerite and the first deutomerite. This width is retained throughout the second deutomerite.

Taken at Berlin and Poitiers. Hosts: *Geotrupes* sp. and *Geotrupes stercorarius* (L.). Habitat: Intestine.

DIDYMOPHYES LEUCKARTI Marshall

[Figures 59, 60]

1893	*Didymophyes leuckarti*	Marshall	1893:41-2

Didymophyes: Sporonts bi- or tri- associative. Length 280 to 1120μ. Width not given. Ratio length protomerite : total length :: 1 : 4 in the association of two; 1 : 11 in the triple association. Ratio width protomerite : width deutomerite :: 1 : 1.3 to 1 : 5. Protomerite dome shaped, broadly rounded, twice as wide as high, constriction at septum. Either 2 or 3 deutomerites, attached one behind the other, each nucleated and separated from others by a straight septum and a conspicuous constriction. Deutomerites barrel shaped, but little wider than protomerite, last one tapering and ending in a more or less broadly rounded extremity. Endocyte dense in both protomerite and deutomerite. Nuclei spherical, containing many small chromatin bodies.

Cysts spherical, one long spore duct. Spores not known. Hosts: *Aphodius prodromus* (Brahm.) and *A. nitidulus* F. Habitat : Intestine.

The cyst dehiscence as seen by Marshall does not coincide with that reported by Léger. The latter mentions simple rupture; the former dehiscence by one long spore duct. If the methods described by both authors are to be accepted, various species in the same genus must have different modes of dehiscence.

DIDYMOPHYES MINUTA (Ishii) Watson

[Figure 71]

1914	*Gregarina minuta*	Ishii	1914:436-7
1916	*Didymophyes minuta*	Watson	(This paper)

Didymophyes: Sporonts elongate. Length 188μ, width 26μ. Ratio length protomerite : total length :: 1 : 23; width protomerite : width deutomerite :: 1 : 1.5. Protomerite flattened somewhat, twice as wide as high, deep constriction at septum. Deutomerites cylindrical, about equal in length, constriction between the two, posterior end broadly rounded. Nuclei spherical, one large karyosome in each. Endoplasm not dense.

Cyst and spores unknown.

Taken in the Province of Izu, Japan. Host: *Tribolium ferrugineum* F. Habitat: Intestine.

Under the name *Gregarina minuta,* Ishii described and illustrated two species of gregarines, one proving to be the above member of the family Didymophyidae, the other a true Gregarina. The two forms were shown to be different by the absence of a protomerite in the satellite in the former and its presence in the latter. There was also a difference in the size of the two kinds of associations. The smaller were those of a true Gregarina, having a protomerite in the satellite, and the name used by the author, *Gregarina minuta,* applies to them only. The larger associations are those of the other form, and I have called this species ***Didymophyes minuta*** (Ishii). For a more detailed argument concerning these species, see appendix at the end of this chapter.

ACTINOCEPHALUS CONICUS (Dufour) Frantzius

[Figures 75, 76, 101, 102, 103]

1826	sp.	Dufour	1826 :43
1828	– – *Conica*	Dufour	1828 :367
1837	*Gregarina conica*	Dufour	1837 :12
1848	*Actinocephalus Lucani*	Stein	1848 :223
1848	*Actinocephalus Lucanus*	Frantzius	1848 :195
1848	*Actinocephalus conicus*	Frantzius	1848 :195
1851	*Gregarina Lucani*	Diesing	1851 :14
1851	*Gregarina conica*	Diesing	1851 :8
1863	*Gregarina Lucani*	Lankester	1863 :95
1863	*Gregarina conica*	Lankester	1863 :95
1892	*Stephanophora radiosa*	Léger	1892 :127
1899	*Stephanophora lucani*	Labbé	1899 :23
1913	*Actinocephalus lucani*	Ellis	1913b :277

Actinocephalus: Sporonts solitary, length 300 to 400μ. Width not given. Ratio length protomerite : total length :: 1 : 5 (without epimerite); width protomerite : width deutomerite :: 1 : 3. Protomerite nearly globular, carrying at the apex a persisting epimerite, situated upon a thick prominent neck. Epimerite larger than protomerite, consisting of hemispherical plateau around the periphery of which is situated a corona of 12 or more large upwardly directed digitiform processes. Deep constriction at septum. Deutomerite widest above middle, tapering but ending in a blunt, rounded extremity. Nucleus spherical with several karyosomes or a band of chromidial bodies. Endocyte yellowish.

Cysts spherical, 250μ in diameter. Spores long, cylindrical, biconical at ends, 13.5 by 4.5μ.

Taken at Berlin and at Tourraine (France). Host: *Dorcus parallelopipedus* (L.) *(Lucanus p.* Fabricus). Habitat: Intestine.

There was considerable confusion regarding this species more than half a century ago. Dufour (1826:43) said:

> "Dans le tube alimentaire de divers Coleoptéres, notamment du *Lucanus parallelopipedus,* de plusieurs Melasomes et de la *Timarcha tenebricosa,* j'ai trouve abondamment une espéce de Vers intestineaux, dont je joins ici le dessin."

It is interesting to note that he called the gregarine an intestinal worm. Two years later he added:

> "L'espèce que j'ai dit habiter les entrailles de divers Coleoptéres, merite, à cause de sa forme, le nom Conica."

By this time Dufour was evidently including many species of gregarines under the same name, not differentiating them from one another.

In 1837, he described in detail, covering two pages, a new genus he established to include a half dozen species which he had discovered, and called the genus Gregarina. One of the species enumerated is *Gregarina conica* and its hosts are given as Coleoptera and Gryllus. That at least two species were concerned in this inclusion is indicated by his figures 7 and 7a, Pl. I, copied in my figures 101 and 102. The figures are similar in one respect, they are both conical at the posterior ends. The protomerites, however, are very unlike. Figure 101 compares favorably, despite its fanciful epimerite, with Stein's figure 35, Pl. IX (1848), my figure 75, from the intestine of the same beetle. These two species are probably the same and the name of the species should thus be *Actinocephalus conicus* (Dufour) Frantzius, Dufour having first named the species and Frantzius having placed it properly.*

Frantzius (1848) recorded both *Actinocephalus conicus* Dufour and *A. Lucanus* Stein and he mentioned as host of the former Gryllus, and of the latter Lucanus.

Diesing recorded *Gregarina conica* Dufour from ''Coleopterorum et Gryllorum ventriculus (Dufour)'' and *G. lucani* Stein from *Lucanus parallelopipedus.*

Lankester listed both species. Léger (1892) described the species as a new one under the name *Stephanophora radiosa.* His description

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*Dufour's Figure 7a is placed in the chapter on Orthopteran Parasites, under the heading Indeterminate Species, *G. conica* Duf.

of the new genus Stephanophora does not differ from Stein's genus Actinocephalus. Léger's words are as follows:

> "Appareil de fixation – – constitué par un plateau epais bordé d'une couronne de tentacules globuleux.
>
> Grégarines toujours solitaires, fixeés pendant la plus grande partie de leur existence; – – –.
>
> Kystes spheriques dehiscents par simple rupture – – –. Spores cylindro-biconiques."

Stein's diagnosis of the genus is as follows:

> Die andre Form des Haftapparates ensteht dadurch, dass sich der Kopf nach vorn in einen kurzen Stiel verengert, der sich in eine flache, runde, am Rande gekerbte, auf dem Stiel senkrecht stehende Schiebe erweitert. [My Fig. 75]. Die vordere, zum Anheften dienende Fläche der Schiebe ist in der Mitte in einer, dem Durchmesser des Stiels gleichkommenden Ausdehnung glatt, von diesem glatten Centrum aus aber bis zur Peripherie sehr regelmässig strahlenfőrmig in Falten gelegt. Jede Einfaltungsfurche fällt einer Einkerbung des Seheibenrandes zusammen. Ich vereinige die mit einem solchem Haftapparat versehenen Formen zu der Gattung Actinocephalus."

The two descriptions are thus synonymous and but one species is involved, as well as but one genus, the epimerite being stalked, with digitiform processes radiating from a flat central plate. In Stein's drawing the processes turn backwards, in Léger's they point directly forward, but this is of no import.

Labbé saw the error in considering the two species distinct. He united them under the species name given by Stein, leaving the species in the genus of Léger, calling the form *Stephanophora lucani* (Stein). Ellis replaced the species in the genus to which it was assigned by Stein. But, according to priority, and from the exhibition of all the evidence in the case, the species name given by Dufour should stand valid and the species be called *Actinocephalus conicus* (Dufour) Frantzius.

The removal of the species from the genus Stephanophora takes from the genus the type and only species and the genus thus drops out of usage.

ACTINOCEPHALUS DYTISCORUM (Frantzius) Watson

[Figure 148]

1848	*Sporadina Dytiscorum*	Frantzius	1848 :195
1851	*Gregarina Dytiscorum*	Diesing	1851 :12
1863	*Gregarina Dytiscorum*	Lankester	1863 :94
1890	*Ancyrophora uncinata*	Labbé	1899 :28-9
1916	*Actinocephalus dytiscorum*	Watson	(This paper)

Actinocephalus: Sporonts robust. Ratio length protomerite : total length :: 1 : 7; width protomerite : width deutomerite :: 1 : 1. Protomerite broad and low, twice as wide as high, flattened in front. Very slight constriction at septum. Deutomerite at septum same width as protomerite in front in septum, retaining same width throughout anterior half. Posterior half much narrower, tapering to a blunt point. Cysts large, spherical, spores not known.

Taken at ———, Germany. Host: *Dytiscus* sp. Habitat: Intestine.

This species is known from the drawings of Frantzius, one being of an adult sporont (?) and the other of a cyst. Diesing gives as host *Dytiscus marginalis* larva. Labbé regards the species as synonymous with *Ancyrophora uncinata* Léger, from a similarity of the host, *Dytiscus.*

The sporont, however, has no resemblance to that of Léger's species, and, although the epimerite of the species in question is not known, it seems to have an individuality.

ACTINOCEPHALUS STELLIFORMIS Schneider

[Figures 67, 69, 73]

1875	*Actinocephalus stelliformis*	Schneider	1875 :588-9
1893	*Actinocephalus stelliformis*	Pfeiffer	1893 :5-11

Actinocephalus: Dimensions not given. Ratio length protomerite : total length :: 1 : 4.5 to 1 : 8; width protomerite : width deutomerite :: 1 : 1.4. Protomerite cylindrical, surmounted by a broadly rounded anterior extremity; same width throughout posterior half, width equal to length. Constriction at septum. Epimerite persisting, a small globular structure surmounted by a corona of recurved processes, each slender at the base, dilated and bifid at the distal extremity. Deutomerite widest above the middle, tapering to a long, sharply pointed extremity. Endocyte very dense. Nucleus small, spherical. Cyst and spores unknown.

Taken at Paris. Hosts: *Ocypus olens* (Mull.) *(Staphylinus o.)* larva and adult; *Carabus auratus* L.; *Carabus violaceus* L.; and *Rhizotrogus* sp. lv. Habitat: Intestine.

Schneider mentions three varieties of this species: a) body regularly lanceolate, epimerite persistent; b) body subspherical; c) body extremely elongate. Pfeiffer found the species in *Carabus violaceus* L.

ACTINOCEPHALUS DIGITATUS Schneider

[Figure 66]

1875	*Actinocephalus digitatus*	Schneider	1875:590

Actinocephalus: Sporonts solitary, short, obese. Measurements not given. Ratio length protomerite : total length :: 1 : 4.5. Ratio width protomerite : width deutomerite :: 1 : 1.4. Protomerite dome-shaped, widest in posterior half, width equal to height. Constriction at septum. Deutomerite rather short, widest a short distance below septum and tapering gradually to a sharp point. Nucleus small, spherical. Epimerite persistent, a globular structure surmounted by a rosette of 8 to 10 recurved digitiform processes rounded at their extremities. Cysts and spores unknown.

Taken at Paris. Host: *Chlaenius vestitus* (Payk.). Habitat: Intestine.

Schneider says:

> "L'*Actinocephalus Lucanus* de Stein, provenant de la larva d'un *Lucanus parallelopipedus,* est une espèce fort voisine de celle-ci."

ACTINOCEPHALUS ACUTISPORA Léger

[Figures 212, 213]

1892	*Actinocephalus acutispora*	Léger	1892:142
1899	*Actinocephalus acutispora*	Labbé	1899:26

Actinocephalus: Sporonts solitary, length 1000 to 1500μ. Width not given. Ratio length protomerite : total length :: 1 : 11; ratio width protomerite : width deutomerite :: 1 : 1.4. Protomerite 1.5 times as long as wide, cylindrical, rounded at the top and slightly dilated in posterior fourth. Constriction at septum. Deutomerite very long and slender, slightly wider than protomerite at shoulder and tapering to a long acutely pointed posterior extremity. Epimerite a spherical button situated upon a short collar and consisting of 12 slender incurved processes terminating in obtuse points. Endocyte brownish yellow. Nucleus spherical, containing 3 to 7 karyosomes.

Cysts ovoidal, 550 to 600μ by 280μ. Dehiscence by simple rupture. Spores obese, acutely pointed, two sizes, 4.5 by 2.8μ and 6.4 by 3.6μ.

Taken at Poitiers, France. Host: *Silpha laevigata* F. Habitat: Intestine.

ACTINOCEPHALUS AMERICANUS Crawley

[Figure 64]

1903 *Actinocephalus americanus* Crawley 1903a:636

Actinocephalus: The generic determination of this species is not absolute. Crawley's description is quoted below:

> "This species is created for a single individual found in *Galerita bicolor* Drury. – – – . It is placed in the genus Actinocephalus on account of the form of both protomerite and deutomerite, the presence of several karyosomes in the nucleus and the fact that the host was a carnivorous Arthropod. The gregarine was 200μ long, 35μ of which represented the length of the protomerite, 45μ broad. The epicyte – – showed a little papilla at the anterior tip of the protomerite. – – The endocyte was much denser in the deutomerite than in the protomerite. – – –."

It is probable that Crawley's determination is correct but the recovery of cysts and spores as well as the epimerite is needed to substantiate the determination.

ACTINOCEPHALUS HARPALI (Crawley)

[Figure 70]

1903 *Gregarina harpali* Crawley 1903:49
1903 *Actinocephalus harpali* Crawley 1903a:637-8

Actinocephalus: Sporonts solitary, obese. Length 225 to 1200μ. Width not given. Ratio length protomerite : total length :: 1 : 6.5; width protomerite : width deutomerite :: 1 : 1.2. Protomerite broadly dome-shaped, twice as wide as high, flattened at the free end, deeply constricted at the septum. Deutomerite widest a short distance below septum where it is but little wider than the protomerite, tapering from anterior fourth to a blunt posterior end. Endocyte very dense, blackish, of equal density in protomerite and deutomerite. Nucleus large, spherical, containing several karyosomes.

Cysts spherical, 640μ in diameter, dehiscing by simple rupture. Spores 9 by 7.5μ, diamond shaped.

Taken at Wyncote, Pa. Host: *Harpalus caliginosus* Fab. Habitat: Intestine.

> "These gregarines were present in the intestine of the one beetle examined in hundreds."

ACTINOCEPHALUS DICAELI (Crawley) Watson

[Figure 100]

1903	*Gregarina discaeli*	Crawley	1903:47
1903	*Gregarina dicaeli*	Crawley	1903a:641
1913	*Actinocephalus discaeli*	Ellis	1913b:279
1916	*Actinocephalus dicaeli*	Watson	(This paper)

Actinocephalus: Sporonts solitary, greatly elongate. Length 1200μ. Ratio length protomerite : total length :: 1 : 15; width protomerite : width deutomerite :: 1 : 1.2. Protomerite pentagonal, seen in lateral optical section, widest through middle, flattened on top, width about equal to height. Slight constriction at septum. Deutomerite very elongate, cylindrical, slightly tapering to a blunt point. Epimerite not known. Endocyte dense, opaque in deutomerite, nearly transparent in protomerite. Nucleus spherical, with several karyosomes. Cyst and spores not known.

Taken in Pennsylvania. Host: *Dicaelus ovalis* Lec. Habitat: Intestine.

Crawley placed this species in the genus Gregarina, with a question. In his later paper (1903a) he left it in the same genus but in a list of eight doubtful species.

> "This gregarine is placed in the genus Actinocephalus because of the general shape of the sporont and the coleopteran host; it was removed from the genus Gregarina because the sporonts do not form associations."

Its generic position is still doubtful and from the data at hand might belong to any of these families: Actinocephalidae, Stylocephalidae or Acanthocephalidae.

The generic name of the host and the specific name of the parasite were both misspelled by Crawley in his original paper. This error was corrected in his second memoir; but Ellis copied the original error, overlooking Crawley's careful explanation of the misprint.

ACTINOCEPHALUS CRASSUS (Ellis)

[Figure 68]

1912	*Stephanophora crassa*	Ellis	1912a :688-9
1913	*Actinocephalus crassus*	Ellis	1913b :278

Actinocephalus: Sporonts solitary, obese. Length 50 to 60μ; width not given. Ratio length protomerite : total length :: 1 : 3.3 to 1 : 3.5. Width protomerite : width deutomerite :: 1 : 1 to 1 : 5. Protomerite dome shaped, a little wider than high, constricted at septum. Deutomerite widest in anterior third, where it is a little wider than the protomerite, narrowing abruptly to a rather sharply pointed posterior extremity. Nucleus small, spherical. Cyst and spores not known.

Taken at Quirigua, Guatemala. Host: *Leptochirus edax* Sharp. Habitat: Intestine.

The determination of the species above is not absolute. Since generic diagnoses depend on the character of the epimerite and the spores as well as on other factors, the absence of these factors tends to make the determination indeterminate. By elimination of negative factors, however, the generic determination is probably correct.

ACTINOCEPHALUS ZOPHUS (Ellis)

[Figure 74]

1913	*Stephanophora zopha*	Ellis	1913a :201-2
1913	*Actinocephalus zophus*	Ellis	1913b :278

Actinocephalus; Sporonts elongate, length 1200 to 1600μ. Width not given. Ratio length protomerite : total length :: 1 : 8 to 1 : 13; width protomerite : width deutomerite :: 1 : 1.7. Protomerite globose, rounded in front. Constriction at septum. Width same as length. Deutomerite slender, elongate. Widest at shoulder, cylindrical, tapering at posterior end to a sharp point. Epimerite persistent, constriction at base and terminating in a corona of 9 or more small regular, rounded, digitiform processes. Endocyte brown, nucleus not seen. Cyst and spores not known.

Taken at New Orleans, La., and at East Falls Church, Va. Hosts: *Nyctobates barbata* Knoch *(N. barbarata* Kn.); *Nyctobates pennsylvanica* deGeer. Habitat: Intestine.

This species was described by Ellis as belonging to the genus

Stephanophora; an error he afterwards corrected and placed the species in the present genus.

Ellis mentions the fact that the record of a species found by Crawley among Leidy's manuscripts seems to indicate that the latter is the same species as that which he describes as *A. zophus.* His words are as follows:

> "Figs. 29 and 30 (Crawley 1903, Pl. III), as taken from Leidy's Mss. are of different Gregarines, a fact recognized by Crawley. Fig. 30 represents a gregarine closely related to *G. grisea,* while Fig. 29 is apparently of a sporont of *S. zopha.*"

A comparison of *S. zopha* (Fig. 74 of this paper) and of Leidy's drawing (Fig. 65 of this paper) will indicate that there is a difference in the shape of the sporonts. The protomerite of Leidy's species is wider than the deutomerite; in Ellis', narrower. In the former it is flattened, in the latter elongated. The deutomerite in the former tapers from the septum to a long, sharply pointed posterior extremity. In *S. zopha* the deutomerite is widest at the shoulder, a little below the septum and is cylindrical for two-thirds of its length, ending in a slightly tapering, bluntly pointed cone. From these facts and because the epimerite of Leidy's species was not seen, I am inclined to think the two species are not identical and that the one in Leidy's drawing should be relegated to the list of indeterminate species. (See list of such species at end of this chapter).

ACTINOCEPHALUS GIMBELI (Ellis) Watson

[Figures 126, 127]

1913	*Stenophora gimbeli*	Ellis	1913:464
1916	*Actinocephalus gimbeli*	Watson	(This paper)

Actinocephalus: Sporonts solitary, obese. Length 520μ. Width not given. Ratio length protomerite : total length :: 1 : 5 to 1 : 6. Ratio width protomerite : width deutomerite :: 1 : 2. Protomerite broadly rounded in front, widest in middle portion, twice as wide as high. Conspicuous constriction at septum. Deutomerite ovoidal, widest through middle, tapering and ending in a bluntly pointed posterior extremity. Endocyte very dense, black in deutomerite, lighter in protomerite, but dense in anterior end. Nucleus not seen. Cyst and spores not known.

Taken at Vincennes, Indiana. Host: *Harpalus pennsylvanicus* Dej. Habitat: Intestine.

Ellis described this species as a Stenophora because of

> "– – the papilla at the anterior end, which results from the expansion of the thin epicyte. Such a process has already been described by the writer (1912:681-6) in another species of this genus, *S. cockerellae* Ellis, from Guatemala."

The shape of the protomerite is very unlike that of the Stenophoridae, being twice as wide as high, while in this family it is globular or subglobular. The Stenophoridae are confined to the Diplopoda. Although no positive factors are present to indicate its position, yet from exclusion of factors, this species would fall under the family Actinocephalidae. The general shape is not unlike that of *Actinocephalus conicus* (Dufour) Stein (Figs. 75 and 76). The two most important determinative factors, epimerite and spores, are unknown and so the determination cannot be absolute.

ASTEROPHORA PHILICA (Leidy) Crawley

[Figures 78, 113]

1889	*Gregarina philica*	Leidy	1889:9-10
1903	*Asterophora philica*	Crawley	1903:53
1913	*Anthorhynchus philicus*	Ellis	1913b:280

Asterophora: Sporonts solitary, very elongate. Length 300 to 2000μ. Maximum width 150μ. Ratio length protomerite : total length :: 1 : 10 to 1 : 15; width protomerite : width deutomerite :: 1 : 1.3. Protomerite conical, sharply pointed when deprived of epimerite, longer than wide. Constriction at septum not deep. Deutomerite widest at shoulder, tapering from thence to an attenuated, sharply pointed posterior extremity. Epimerite a circular, flattened cushion with a fluted periphery, situated upon a short neck at the apex of the protomerite. Endocyte and nucleus not described.

Cyst and spores not known.

Taken at Philadelphia, Pa. Host: *Nyctobates pennsylvanica* deGeer *(N. pennsylvanicus)*. Habitat: Intestine.

The above description is taken from Leidy (1889). He remarks that

> "– – the epimerite consists of a horizontal circular disc with a round milled border."

In a review of Leidy's Mss., Crawley found three more drawings from the same beetle. Crawley's words concerning his disposition of the same are as follows:

> "Asterophora philica Leidy.
> Gregarina philica Leidy (1889, p. 9, 1 Fig.)
> It is impossible to give a description of this species. Figs. 31 and 32 are

> very plainly of the same gregarine, whereas Fig. 33 seems almost certainly to belong to a different species. Further, the form figured by Leidy in 1889 is not so closely like that shown by Figs. 31 and 32 as to render it certain that the two are the same.
>
> I therefore include the three different forms under the same name, giving only the figures and reference, until such time as sufficient material is obtained to determine accurately what the actual facts may be.
>
> The gregarines figured were about 300 microns long."

It is evident that the form figured by Leidy (1889; my figure 113) and in his Mss. (my figure 78), are the same species. The proportions agree, the shapes of the protomerite are very similar, and the epimerite shown on figure 78 coincides with Leidy's description of the epimerite.

Crawley's figure 32 (my figure 104), may or may not be a cephalont of the same species, but the figure 33 (my figure 105), is obviously unlike and must be placed among the uncertain species. (See group at end of chapter).

Ellis placed the species in the genus Anthorhynchus, but the epimerite, as described by Leidy, coincides with Labbé's description of the genus Asterophora (1899 :22) :

> "Épimérite en forme de bourrelet circulaire à côtes saillantes radiees en portant qu centre un mammelon saillant. Sporadin – – – allongée,"

except that Leidy does not mention the central papilla. The description of the genus Anthorhynchus does not fit the case (Labbé 1899 :19) :

"Epim. en gros bouton cannelé."

ASTEROPHORA CRATOPARIS Crawley

[Figure 77]

1903	*Asterophora cratoparis*	Crawley	1903 :54
1913	*Anthorhynchus cratoparis*	Ellis	1913b :279

Asterophora: Length 540μ. Width not given. Ratio length protomerite : total length : : 1 : 5; width protomerite : width deutomerite : : 1 : 1.1. Protomerite nearly reniform with conical projection at apex upon which rests the epimerite. Protomerite 1.5 times as wide as high. Deep constriction at septum. Deutomerite widest at shoulder, tapering thence and terminating bluntly. Epimerite consisting of a number of "ribs projecting from a central knob." Endocyte not described. Nucleus spherical, with one karyosome.

Cysts and spores unknown.

Taken at Swarthmore, Pa. Host: *Cratoparis lunatus* Fab. Habitat: Intestine.

Ellis removed this species from the genus in which it was first placed, and included it among the members of the genus Anthorhynchus. This genus and Asterophora are differentiated by the character of the epimerite and spores. In our present discussion, the latter factor may be omitted since the spores are not known. The epimerite of Anthorhynchus is a large canaliculated button; that of the Asterophora consists of a circular cushion with a central knob and with a fluted, crenulate periphery. Crawley's species, therefore, coincides with the latter description and should be returned to that genus.

BELOIDES FIRMUS (Léger) Labbé

[Figures 116, 214]

1892	*Xiphorhynchus firmus*	Léger	1892 :137-9
1899	*Beloides firmus*	Labbé	1899 :26-7

Beloides: Sporonts solitary, elongate. The adults 80μ in length. Protomerite conical, dilated in center, constriction at septum. Deutomerite widest at shoulder, tapering to a sharp point. Ratio length protomerite : total length : : 1 :3.8; width protomerite : width deutomerite : : 1 : 1.2. Nucleus elongate ellipsoidal, with several karyosomes. Epimerite a stalked globose papilla with 12 large lateral curved spines and a long rigid central style (80μ long in adults).

Cysts spherical, $180-200\mu$ in diameter, dehiscence by simple rupture, biconical, 14.5 by 6μ.

Taken at Poitiers, France. Host: *Dermestes lardarius* L., larva. Habitat: Intestine.

BELOIDES TENUIS (Léger) Labbé

[Figure 117]

1892	*Xiphorhynchus tenuis*	Léger	1892 :139
1899	*Beloides tenuis*	Labbé	1899 :26-7

Beloides: Sporonts solitary, elongate. Epimerite a stalked globular papilla, with 12 stiff lateral curved spines surmounted by a long slender sinuous style.

Cysts spherical, spores biconical, pointed.

Taken at Poitiers, France. Host: *Dermestes undulatus* Brahm, larva. Habitat: Intestine.

Labbé changed the genus name of this and the foregoing species because of priority.

BOTHRIOPSIS HISTRIO Schneider

[Figures 79, 81]

1875	*Bothriopsis histrio*	Schneider	1875:596
1892	*Bothriopsis histrio*	Léger	1892:136-7
1903	*Bothriopsis histrio*	Crawley	1903:54-5

Bothriopsis: Sporonts solitary, maximum length 425μ. Width not given. Ratio length protomerite : total length sporont :: 1 : 1.6. Width protomerite : width deutomerite :: very variable. Length of protomerite more than half that of the whole sporont. Septum strongly convex upward into protomerite. Deutomerite stout, spindle shaped, ending in a sharp point. Epimerite a small flattened disc from which project a half dozen long slender filaments. Nucleus ovoidal, generally placed diagonally, containing several karyosomes. Endocyte yellow in young, brownish black in adults.

Cysts spherical, 400 to 500μ. Spores obese, biconical, 7.2 by 5μ.

Taken at Paris and Tourraine, France, and at Wyncote, Pa. Hosts: *Hydaticus cinereus,* larv.; *Colymbetes fuscus; Acilius sulcatus;* and *Dytiscus* sp. larv. Habitat: Intestine.

Schneider stated that this species is highly polymorphic, and he described two varieties, the type form and a variety *marginata,* which is more active. He found no epimerite, but this was discovered later by Léger, who described it as consisting of six slender filaments, 80 – 90μ long. Léger also discovered the spores.

Crawley's observations on this species vary somewhat from those of Schneider; for instance, he says:

> "– – – the protomerite is a large rounded mass, but whereas Schneider's figures represent it to be solid, I find that it contains, at least in some cases, a large cavity. Within this cavity was a fluid in which floated a few granules. – – – the septum dips backward. In a number of cases, however, the septum dipped forward, and such appears to be the only condition seen by Schneider. – – –."

Crawley found that in the stained specimens the protomerite is more densely granular than the deutomerite.

BOTHRIOPSIS TERPSICHORELLA (Ellis) Watson

[Figure 80]

1913	*Legeria terpsichorella*	Ellis	1913b:276
1916	*Bothriopsis terpsichorella*	Watson	(This paper)

Bothriopsis: Sporonts solitary, average length 720μ. Width 145μ. Ratio length protomerite : total length :: 1 :1 to 1.8 : 1. Ratio width protomerite : width deutomerite : : 1.3 : 1. Protomerite equal to or longer than deutomerite, the anterior fourth hemispherical to subglobose, below which is an elevated flange-like portion, remaining two thirds cylindrical. No constriction at septum. Septum projecting forward into protomerite like the finger of a glove. Deutomerite ovoidal, tapering, bluntly pointed posteriorly. Endocyte dense, homogeneous, light brown.

Cysts and spores not known.

Taken at Douglas Lake, Mich. Host: *Hydrophilus* sp. Habitat: Intestine.

This species was described by Ellis as a member of the genus Legeria. His description is as follows:

> "Epimerite not seen; sporonts extremely active, constantly changing the shape of the anterior three-fifths of the body and proceeding rather rapidly in a serpentine path as a result, the protomerite often being bent almost forty-five degrees from the main axis of the body; expanded individual with a protomerite equal to or longer than the deutomerite, the anterior fourth of the protomerite hemispherical to subglobose, below which is an elevated flange-like portion, remaining two thirds cylindrical, the posterior portion with a cup-shaped depression some 60° deep into which the anterior conical portion of the deutomerite fits; deutomerite excepting the portion included by the protomerite ovoid, rather sharply rounded posteriorly; average sporonts 720μ in length; – – –."

A comparison of figure 82, a copy of *Legeria agilis* (Schn.) Labbé with figure 80, Ellis' species in question, reveals differences in the two. The genus Legeria is characterized by: a) deutomerite spindle shaped(same as in Bothriopsis) ; b) protomerite much less than half the total length; c) protomerite cylindrical, dilated in anterior third, terminating in a simple obtuse angled cone; d) septum broadly convex upward into the protomerite in the shape of an hemisphere; e) nucleus spherical; f) agility of movement not confined to protomerite, but equally active in both segments. The species in question does not belong in this genus for the protomerite occupies more than half the total length, it does not terminate in a cone, the septum is not broadly dome shaped and movement is not equally active throughout the sporont.

Bothriopsis is diagnosed by Schneider as having a) an unusually well developed protomerite consisting of a large polymorphic mass convex or concave at its anterior end and nearly or equally as long as, or longer than, the deutomerite, cylindrical in posterior two thirds; b) a septum invaginated into the protomerite like the finger of a glove; c) an ellipsoidal nucleus; d) endocyte yellow to dark brown; e) agility of movement chiefly confined to the protomerite.

The species in question coincides with the genus Bothriopsis in these characteristics: 1) polymorphism chiefly confined to anterior three fifths of body; 2) protomerite equal to or longer than deutomerite; 3) protomerite largest in anterior third, posterior two thirds cylindrical; 4) septum invaginated into protomerite for the posterior third of its length; 5) endocyte light brown.

I have therefore changed the name of the species to *Bothriopsis terpsichorella.*

LEGERIA AGILIS (Schneider) Labbé

[Figure 82]

1875	*Dufouria agilis*	Schneider	1875:595-6
1899	*Legeria agilis*	Labbé	1899:24

Legeria: Sporonts solitary; measurements not given. Ratio length protomerite : total length :: 1 : 2.5 to 1 : 3. Width protomerite : width deutomerite :: 1.1 : 1. Protomerite irregularly cylindrical, considerably dilated in anterior third, terminated by an obtuse angled cone as wide as high. No constriction at septum. Septum convex upward into protomerite. Deutomerite irreguarly cylindrical, tapering from middle to a sharp point. Nucleus spherical, containing several karyosomes.

Cysts spherical, dehiscing by simple rupture. Spores cylindro-biconical.

Taken at Paris. Host: *Colymbetes* sp. larv. Habitat: Intestine.

PHIALOIDES ORNATA (Léger) Labbé

[Figures 87, 88]

1892	*Phialis ornata*	Léger	1892:135
1899	*Phialoides ornata*	Labbé	1899:24

Phialoides: Sporonts solitary, rather obese. Average length 1200μ. Width not given. Ratio length protomerite : total length :: 1 : 3.3; width protomerite : width deutomerite :: 1 : 1.2. Protomerite subglobular, as wide as high, constriction at septum. Deutomerite broadly ellipsoidal, widest in middle, broadly rounded behind. Epimerite persistent, a long slender cylinder, nearly as long as the whole sporont (exclusive of the epimerite), terminating in a dome shaped retractile structure surrounded by a thickened collar, above which is a ring of fine triangular chitinous teeth. Nucleus spherical, containing several karyosomes.

Cysts spherical, 300 to 400μ in diameter, dehiscing by simple rupture. Spores biconical, swollen in middle, 10.5 by 6.75μ.

Taken at Poitiers, France. Host: *Hydrophilus piceus* (L.) larv. Habitat: Intestine.

Labbé included with this species, as a synonym, Kölliker's *Gregarina brevirostra* (1848:12), probably because of the similarity in hosts. Kölliker's species shows a 'proboscis' as does Léger's, but one much shorter and differently shaped. The former is a short xiphoid cone, only half the length of the protomerite; the latter a long cylindrical process, three times the length of the protomerite. The latter is retractile, but Kölliker does not mention that this is true of his species. His drawing does not indicate the circular distal collar armed with teeth. I am inclined to think the species are quite distinct, and have therefore placed Kölliker's species in the genus Stylocephalus. For further description, see under the heading *Stylocephalus brevirostris* (Kölliker).

PILEOCEPHALUS BERGI (Frenzel) Labbé

[Figure 83]

1892	*Gregarina bergi*	Frenzel	1892:286
1899	*Pileocephalus bergi*	Labbé	1899:20

Pileocephalus: Sporonts solitary, barrel shaped. Length of largest 330μ, width 90μ. Ratio length protomerite : total length : : 1 : 5.2; width protomerite : width deutomerite : : 1 :1.6. Protomerite hemispherical, evenly rounded, 1.7 times wider than high, slight constriction at septum. Deutomerite broadly ellipsoidal, wider in middle, broadly rounded, nearly flattened posteriorly. Epimerite a large hyaline centrally dilated and sharply pointed cone half the length of the whole cephalont without the epimerite. Nucleus spherical with one large karyosome. Endocyte dense, gray to black.

Cyst and spores unknown.

Taken at Cordoba, Argentina. Host: *Necrobia ruficollis* Fabr. *(Corymetes ruf.)*. Habitat: Intestine.

PYXINIA RUBECULA Hammerschmidt

[Figures 119, 159]

1838	*Pyxinia rubecula*	Hammerschmidt	1838:357
1848	*Actinocephalus rubecula*	Frantzius	1848:193, 195
1851	*Gregarina rubecula*	Diesing	1851:12
1863	*Gregarina rubecula*	Lankester	1863:95
1892	*Pyxinia rubecula*	Léger	1892:140
1899	*Pyxinia rubecula*	Labbé	1899:26

Pyxinia: Sporonts solitary, obese. Measurements not given. Ratio protomerite : total length :: 1 : 3.6. Width protomerite : width deutomerite :: 1 : 1.2. Protomerite large, regularly conoidal, a little longer than wide (1.2 : 1), constriction at septum. Deutomerite conical, widest at shoulder, tapering to a slender, pointed extremity. Endocyte dense, of protomerite much less dense. Nucleus ellipsoidal.* Epimerite situated upon a short neck, urn-shaped, wide mouthed, crenulate on the periphery, with a short, stout conical style projecting upward through the center.

Cysts spherical, 250 to 280μ in diameter, spores bluntly biconical, 14 by 7μ.

Taken at ———?, Germany, and at Poitiers, France. Hosts: *Dermestes lardarius* L. larva and *D. vulpinus* Fabr. adult.

PYXINIA CRYSTALLIGERA Frenzel

[Figures 84, 85, 86]

1892	*Pyxinia crystalligera*	Frenzel	1892:314-29

Pyxinia: Sporonts solitary, elongate. Maximum length 750μ. Width not given. Ratio length protomerite : total length :: 1 : 5 to 1 : 10; width protomerite : width deutomerite :: 1.1 : 1. Protomerite spherical in adults. Deutomerite of adults regularly cylindrical, tapering in posterior third to a long, slender, bluntly pointed extremity. Epimerite a short sharp rigid style resting upon a small crenulate corona, the whole superimposed upon the cone shaped protomerite of the cephalont. Endocyte containing large, strongly refractile variously shaped crystals and granules of pyxinin. Nucleus irregularly ellipsoidal, containing several karyosomes.

Cyst and spores not known. Taken at Cordoba, Argentina. Hosts: *Dermestes vulpinus* Fabr.; *Dermestes peruvianus* Casteln., adults and larvae of both. Habitat: Intestine.

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*Frantzius' illustration shows a spherical nucleus.

PYXINIA FRENZELI Laveran and Mesnil

[Figure 89]

1900	*Pyxinia Frenzeli*	Laveran and Mesnil	1900:554-7

Pyxinia: Sporonts solitary, obese. Length 200μ. Maximum length of cephalonts 150μ. Maximum width 40μ. Cephalonts only illustrated. Ratio length protomerite : total length :: 1 : 4; width protomerite : width deutomerite :: 1 : 2. Protomerite (of cephalonts) cylindrical to subglobose, constricted at septum. Deutomerite subglobose, nearly as wide as long. Epimerite in two parts, a slender cylindrical base equal in length to protomerite, and superimposed upon same, and a short, sharp, apical style equal in length to the cylinder. Nucleus spherical, containing a large karyosome.

Cysts not seen; spores ovoidal, 14 by 6μ.

Taken at Paris. Hosts: *Attagenus pellio* (*Dermestes* sp.). Habitat: Intestine.

PYXINIA MÖBUSZI Léger and Duboscq

[Figures 97, 98]

1900	*Pyxinia Möbuszi*	Léger and Duboscq	1900:1566
1902	*Pyxinia Möbuszi*	Léger and Duboscq	1902:409-18

Pyxinia: Sporonts solitary. Length 100 to 140μ. Width not given. Ratio length protomerite : total length :: 1 : 5 to 1 : 6. Width protomerite : width deutomerite :: 1 : 1. Protomerite hemispherical, lower margin straight, projecting beyond deutomerite at septum. Deutomerite regularly cylindrical, ending in a blunt point or in a well rounded extremity. Epimerite persistent, a long slender sinuous style attached to base of the epithelial cell, i. e., to mesothelial wall, of the host, extending through this cell, longitudinally, to lumen, the cephalont body remaining in lumen, beyond cilia. Epimerite as long or longer than the whole cephalont itself. Endocyte containing paramylin granules and small yellow refractile bodies. Nucleus spherical, with one karyosome and several chromatic granules.

Cysts spherical, 60 to 70μ in diameter. Spores elongate, barrel shaped, 6.5 by 7μ long.

Taken at Grenoble (?), France. Host: *Anthrenus verbasci* Olivier, larv. (*A. verbasci* L.) Habitat: Intestine.

STICTOSPORA PROVINCIALIS Léger

[Figures 90, 91]

1893	*Stictospora provincialis*	Léger	1893:129-31
1896	*Stictospora provincialis*	Léger	1896:32
1899	*Stictospora provincialis*	Labbé	**1899:21**

Stictospora: Sporonts, solitary, elongate: Length 1000 to 2000μ. Width not given. Ratio length protomerite : total length :: 1 : 6. Width protomerite : width deutomerite :: 1 : 1.2. Protomerite subglobular, terminating in a broadly conical anterior extremity. Width equal to height. Deep constriction at septum. Deutomerite widest at shoulder, tapering to a slender, sharply pointed distal portion. Nucleus ellipsoidal, with several karyosomes, epimerite consists of a short stalked, globular papilla depressed anteriorly, there proceeding from the depression a dozen long, backwardly directed, sharply pointed processes which fit closely around the papilla and completely cover it. Protoplasm of anterior end of protomerite yellow.

Cysts spherical, 800μ in diameter, dehiscence by simple rupture; spores biconical, slightly curved.

Taken near Marseilles, France. Hosts: Larvae of *Melolontha* sp. and *Rhizotrogus* sp. Habitat: Intestine.

But one species is known in this genus and in the sub-family Stictosporidae.

STEININA OVALIS (Stein) Léger and Duboscq

[Figures 92, 93, 94]

1838	*Clepsidrina polymorpha*	Hammerschmidt	1838:355
1848	*Stylorhynchus ovalis*	Stein	1848:182-223
1848	*Stylorhynchus ovalis*	Frantzius	1848:195
1851	*Gregarina ovalis*	Diesing	1851:9
1863	*Gregarina polymorpha*	Lankester	1863:95
1875	*Clepsidrina polymorpha*	Schneider	1875:580-2
1902	*Gregarina polymorpha*	Berndt	1902:405
1904	*Steinina ovalis*	Léger and Duboscq	1904:352-5
1910	*Steinina ovalis*	Pfeiffer	1910:108

Steinina: Sporonts solitary, obese. Length 100μ. Width not given. Ratio length protomerite : total length :: 1 : 2.5; width protomerite : width deutomerite :: 1 : 1.4. Protomerite cylindrical, terminating in a large cone, as broad as high, no constriction at septum. Deutomerite short, ovoidal, nearly as wide as long, terminating in an obtuse angled cone. Nucleus spherical and containing one large karyosome. Epimerite a short retractile digitiform process which later becomes a flattened button. Cysts spherical or ovoidal, 100μ in diameter, dehiscing by simple rupture. Spores biconical, broad through middle, 9 by 7.5μ.

Taken in France. Host: *Tenebrio molitor* L. larva. Habitat: Intestine.

This is a much discussed and confused species. Early writers grouped together all the polycystid gregarines found in the larva of *Tenebrio molitor* as one species. Hammerschmidt evidently actually found several species for he named the one species he described *Clepsidrina polymorpha.* Stein differentiated three species and separated out this one, even assigning to it a different genus than the other two, *C. polymorpha* and *C. cuneata.*

Schneider described under the name *Clepsidrina polymorpha* (Hamm.) three species, one of them being the *Stylorhynchus ovalis* of Stein. His words are as follows:

> "L'espèce *Clepsidrina polymorpha* â été instituèe par Hammerschmidt, et plus tard démembrée par Stein, qui trouva moyen d'établir à ses dépens trois espèces dont une fut reportee dans le genre Stylorhynchus.
>
> Ce preténdu *S. ovalis* est simplement le céphalin de l'une des variétes que nous allons décrire."

Berndt, in a long paper on the Gregarines of *Tenebrio molitor* larva, still considered this species the cephalont of *G. polymorpha* in 1902.

It remained for Léger and Duboscq (1904) to clear up the discussion. They created a new genus for this species, and called it Steinina.

STEININA OBCONICA Ishii

[Figure 95]

1914 *Steinina obconica* Ishii 1914:439-41

Steinina: Sporonts solitary, obese. Length 120 to 140μ. Width 68 – 80μ. Ratio length protomerite : total length :: 1 : 5 to 1 : 7. Width protomerite : width deutomerite :: 1 : 1. Protomerite dome-shaped, three times as wide as high. Septum constricted slightly at periphery. Deutomerite widest just below septum, and tapering to a slender, bluntly pointed posterior extremity. Epimerite a short conical hyaline projection 1/4 as long as the protomerite is high. Endocyte dense. Nucleus spherical.

Cysts spherical to slightly ovoidal, 120 by 108μ. Spores unknown.

Taken in the Province of Izu, Japan. Host: *Tribolium ferrugineum* F. Habitat: Intestine.

The character of the epimerite is evidence that this species is rightly placed.

STEININA ROTUNDA Watson

[Figure 173]

1915 *Steinina rotunda* Watson 1915:32-3

Host: *Amara angustata* Say. Taken at St. Joseph, Ill., November, 1914. Habitat: Intestine.

A dozen individuals were found in a single host. The sporonts are solitary, the body stout, short and broad. The epimerite persists even on some of the largest individuals. It is a spherical, sessile or shortly stalked and hyaline knob. The protomerite just below it is broadly conical in shape, widening rapidly downward to form a cylinder bulging in the middle portion. A deep constriction is present at the septum. The protomerite is widest three fourths of its length from the anterior end, and, without the epimerite, it is as high as wide. The deutomerite is practically spherical except in its anterior end, which, at the septum, is more or less flattened or sometimes concave downward. The deutomerite widens rapidly from the septum and is as wide as long.

In color, the body is light brown or tan, of equal density in both protomerite and deutomerite; the protoplasm is homogeneous and not very abundant. The anterior half of the protomerite and the epimerite is transparent. The nucleus is visible in vivo in specimens of all ages. In all the specimens attached to the epithelium, no matter how large, the nucleus contains but one karyosome; in the free individuals, no matter how small, a large number of small deeply staining chromosomes are present. The epicyte is thin and of equal width throughout. Longitudinal striations are visible.

Most of the specimens seen possessed epimerites, whether free or attached. A goodly number of these, however, were free in the lumen. The epimerite disappears by being gradually constricted off. When the specimens are on a slide in a water medium for fifteen minutes, approximately, the epimerite breaks, the supposition being that it is highly porous and the sudden strain caused by media of unequal density outside and inside is reduced by the bursting of this fragile structure. When the trophozoite is attached, only the epimerite is embedded and the free ends of several cells are destroyed by the parasite.

Very slow movement of progression was noted. The power of contraction seems to be centered in the anterior part of the deutomerite, for the parasite is able to contract this portion of the body into a narrow neck.

This species is very probably a member of the genus Steinina, family Actinocephalidae, although the cysts and spores are not known. The globular hyaline epimerite corresponds to that of one stage of the epimerite of the type species, *Steinina ovalis,* as described by Léger and Duboscq (1904:352-4). The incipient stylous epimerite and the hat shaped end stage were not observed in this species. The adults are non-associative and in shape of the deutomerite, of the protomerite, and the conoidal anterior projection of the protomerite, together with the nuclear shape and content, coincide with those of the type species. Coupling of sporonts takes place probably just previous to cyst formation and not, as in the genus Gregarina, near the beginning of sporont life.

Some of the important measurements are given below; all dimensions are expressed in microns:

Total length sporont	250	220	180
Length protomerite with epimerite	130	105	70
Length epimerite	20	20	15
Length protomerite without epimerite	110	85	56
Length deutomerite	120	115	110
Width protomerite	130	90	70
Width deutomerite	150	120	85
Ratio			
length protom. (without epimerite) : total length	1:2.3	1:2.5	1:3.3
width protom.: width deutomerite	1:1.1	1:1.3	1:1.2
Diameter nucleus	40	32	40

STEININA HARPALI NOV. SPEC.

[Figures 256-59, 269]

Host: *Harpalus pennsylvanicus longior* (Kirby).

Location, Urbana, Ill., June, 1915.

The parasites were found in the coelom, attached to the intestinal walls of several beetles. The sporonts are solitary, small and obese. The maximum recorded length is 200μ, the average length 150μ, and the maximum width 100μ. The ratio of length protomerite : total length without primite :: 1 : 3 to 1 : 5 and the average ratio of width protomerite :

width deutomerite :: 1 : 1.3. The protomerite is cone-shaped, constricted above the middle, and terminates in almost every instance in a small epimerite. This structure in youngest individuals is a simple short spike; as the animal grows older it becomes a sphere, and finally becomes cup shaped. Old sporonts sometimes lose this epimerite. The protomerite is widest at the septum and there is here a slight constriction which may, however, be lacking. The deutomerite is ovoidal, widest at the shoulder just below the septum, and terminates in a broadly rounded or slightly tapering posterior end. The nucleus is visible in young individuals as a minute spherical body.

The protoplasm is dense in the deutomerite, being black in transmitted light; it is nearly as dense in the lower half of the protomerite, but the upper portion of the latter is nearly devoid of endoplasm. The epimerite is clear.

Cysts are dense, spherical and average 120μ in outer diameter. The inner diameter is approximately 90μ. Spores were not seen.

Figures for a few individuals measured are as follows; dimensions are given in microns:

Total length sporont	200	150	105
Length protomerite with epimerite	80	65	50
Diameter epimerite	20	20	18
Length protomerite alone	60	45	32
Length deutomerite	120	85	70
Width protomerite	90	50	105
Width deutomerite	100	80	105
Ratio			
length protom. (without epimerite) : total length	1:3.3	1:3.3	1:3.3
width protom.: width deutomerite	1:1.1	1:1.6	1:1

This species differs from the other species found in the genus Harpalus as follows: *Gregarina parva* (Crawley) Watson and *Hirmocystis harpali* Watson are both associative; *Actinocephalus gimbeli* (Ellis) Watson differs in size and proportions (the epimerite was not seen in the latter species); in *Actinocephalus harpali* (Crawley) the maximum length of the sporonts is 1200μ, and in proportions and sizes of cysts (640μ in the latter), the two species are widely different.

The species is placed in the genus Steinina because the epimerite is a short mobile digitiform process changing through a sphere into a flattened button; the sporonts are small, solitary and obese; the protomerite terminates in a large cone; the cysts are small.

It differs sufficiently in size range from the three other species described in this genus to be designated a separate species.

STYLOCYSTIS ENSIFERA (Ellis)

[Figures 96, 99]

1912	*Stylocephalus ensiferus*	Ellis	1912a :686-7
1913	*Stylocystis ensiferus*	Ellis	1913b :274

Stylocystis: Sporonts solitary, short. Average length 40 to 65μ. Ratio length protomerite : total length :: 1 : 3; width protomerite : width deutomerite :: 1 : 1 to 1 : 4. Protomerite cylindrical, conical to subglobose. Approximately as wide as high. Deep constriction at septum in adults. Deutomerite half as wide as long, widest at shoulder, tapering slightly and ending in a flattened or very broadly rounded posterior extremity. Epimerite a stout style, equal to protomerite in length. Endocyte dark gray, opaque. Nucleus not seen.

Cyst and spores not known.

Taken at Quirigua, Guatemala. Host: *Leptochirus edax* Sharp. Habitat: Intestine.

Ellis first described this species as a member of the family Stylocephalus, later removing it to the family Actinocephalidae.

CYSTOCEPHALUS ALGERIANUS Schneider

[Figures 115, 160]

1886	*Cystocephalus algerianus*	Schneider	1886 :100
1899	*Cystocephalus algerianus*	Labbé	1899 :31

Cystocephalus: Sporonts solitary, ovoidal. Length 3 to 4 mm. Ratio length protomerite : total length :: 1 : 6; width protomerite : width deutomerite :: 1 : 1.7. Protomerite dome shaped, widest at base, twice as wide as high, no constriction at septum. Deutomerite ovoidal, widest through middle, length less than width, posterior end conical, sharply pointed. Epimerite placed upon a short collar, globose, with conical apex. Nucleus elongate ellipsoidal, containing several karyosomes.

Cysts not known. Spores irregularly and peculiarly shaped, 10 by 10.5μ.

Taken in Algeria. Host: *Pimelia* sp. Habitat: Intestine.

LOPHOCEPHALUS INSIGNIS (Schneider) Labbé

[Figures 110, 114, 161]

1882	*Lophorhynchus insignis*	Schneider	1882:435
1885	*Lophorhynchus insignis*	Schneider	1885:14
1899	*Lophocephalus insignis*	Labbé	1899:31

Lophocephalus: Sporonts solitary, very elongate. Length 1000μ. Width not given. Ratio length protomerite : total length :: 1 : 15; width protomerite : width deutomerite :: 1 : 1.3. Protomerite subglobose, flattened, twice as wide as high, constriction at septum. Deutomerite cylindrical, widest at end of anterior third, flattened at posterior extremity. Nucleus of sporont spherical with one karyosome. Epimerite a large flattened disc, depressed slightly in center, crenulate on periphery, longitudinally striated and carrying at base a circle of very many short upwardly directed digitiform processes. The cephalont which possesses the circular disc-shaped epimerite spherical or nearly so. Its nucleus with a coiled chromatin band.

Cysts subspherical or subovoidal, 430 by 330μ in diameter, dehiscing by pseudocyst. Spores extruded in chains, irregularly hat-shaped, 10μ long.

Taken at Tours, Indre-et-Loire, France. Host: *Helops striatus.* Habitat: Intestine.

OOCEPHALUS HISPANUS Schneider

1886	*Oocephalus hispanus*	Schneider	1886:101
1899	*Oocephalus hispanus*	Labbé	1899:32

Epimerite a sphere carried on a short conical neck. Host: *Morica* sp. Habitat: Intestine.

Ellis (1913b:282) includes this genus with Cystocephalus under the name of the latter. The two genera are, however, distinct, having epimerites different in shape; the former being globular, set on a short conical neck, the latter spade-shaped (in side view), i. e. dilated in middle portion and conical at apical end, set on a short cylindrical slender collar.

STYLOCEPHALUS OBLONGATUS (Hammerschmidt) Watson

[Figures 106, 120]

1838	*Rhiziniaoblongata*	Hammerschmidt	1838:357
1848	*Sporadina oblongata*	Frantzius	1848:195
1851	*Gregarina oblongata*	Diesing	1851:14
1875	*Stylorhynchus oblongatus*	Schneider	1875:569
1882	*Stylorhynchus oblongatus*	Schneider	1882:434
1916	*Stylocephalus oblongatus*	Watson	(This paper)

Stylocephalus: Sporonts solitary, elongate. Maximum length 3000μ; width not given. Ratio length protomerite : total length :: 1 : 6 to 1 : 8. Ratio width protomerite : width deutomerite :: 1 : 2. Protomerite globular, constriction at septum. Deutomerite cylindrical, tapering slightly from middle, ending in a rather slender blunt posterior extremity. Epimerite a thick cylindrical neck with a terminal dilated portion with papilla on extremity. Whole epimerite equal to 1.5 to twice the length of protomerite alone. Endocyte yellow in cephalont, becoming black in adult sporont. Nucleus ellipsoidal, with several karyosomes.

Cysts irregularly spherical with slight depressions and protuberances. Spores brown, united in chains, 7μ in long axis.

Taken at Paris and Poitiers, France. Hosts: *Opatrum sabulosum* (L.) and *Asida grisea* (F.) Habitat: Intestine.

Because the name was preoccupied, Ellis renamed the genus Stylorhynchus, Stylocephalus. The species thus becomes *Stylocephalus oblongatus.*

STYLOCEPHALUS LONGICOLLIS (Stein) Watson

[Figures 107, 121]

1815	*Gregarina* sp.	Gaede	1815:17
1848	*Stylorhynchus longicollis*	Stein	1848:222
1848	*Stylorhynchus longicollis*	Frantzius	1848:195
1851	*Gregarina Mortisagae*	Diesing	1851:12
1863	*Gregarina longicollis*	Lankester	1863:95
1875	*Stylorhynchus longicollis*	Schneider	1875:572
1882	*Stylorhynchus longicollis*	Schneider	1882:423
1884	*Stylorhynchus longicollis*	Schneider	1884:1-36
1916	*Stylocephalus longicollis*	Watson	(This paper)

Stylocephalus: Sporonts solitary, elongate. Measurements not given. Ratio length protomerite : total length :: 1 : 10; width protomerite : width deutomerite :: 1 : 1.1. Protomerite pentagonal in lateral optical view, truncate at apex, slight constriction at septum, width equal to length. Deutomerite elongate, cylindrical, tapering in posterior two thirds and ending in a rather blunt point. Nucleus ellipsoidal, with several karyosomes. Endocyte dense. Epimerite consisting of a long slender cylindrical neck, terminating in a slightly dilated papillate anterior end, the whole three or four times the length of the protomerite alone.

Cysts irregularly spherical, surface covered with small indentations and papillae. Spores like those of *S. oblongatus.*

Taken at Paris. Host: *Blaps mortisaga.* Habitat: Intestine.

STYLOCEPHALUS BREVIROSTRIS (Kölliker) Watson

[Figure 118]

1848	*Gregarina brevirostra*	Kölliker	1848 :12
1848	*Stylorhynchus brevirostris*	Frantzius	1848 :195
1851	*Gregarina brevirostrata*	Diesing	1851 :9
1863	*Gregarina brevirostris*	Lankester	1863 :95
1899	*Phialoides ornata*	Labbé	1899 :24
1916	*Stylocephalus brevirostris*	Watson	(This paper)

Stylocephalus: Sporonts solitary, stout bodied. Ratio length protomerite : total length :: 1 : 4; width protomerite : width deutomerite :: 1 : 1.2. Protomerite cylindrical, of nearly equal width throughout, width equal to length, no constriction at septum, corners rounded at anterior end. Epimerite a small xiphoid conoidal tongue projecting upward from center of protomerite, length equal to half that of protomerite. Deutomerite just below septum a little wider than protomerite, tapering to a rather sharp point. Nucleus spherical, with six to nine small karyosomes. Cyst and spores unknown.

Taken at ———, Germany. Host: *Hydrophilus* sp. larva. Habitat: Intestine.

Kölliker illustrated another figure of this species besides the one copied in figure 118, in which the whole body is less angular in outline (1848, Pl. 2, Fig. 15); the epimerite is a sphere, the protomerite nearly so also, and the deutomerite ellipsoidal with a well rounded posterior extremity. The animal is drawn under abnormal conditions, however, a drop of egg albumen having been used as a medium and the animal left in it for some time.

Frantzius placed this species where it evidently belongs, in the genus Stylocephalus, then called Stylorhynchus. His definition of the genus is "Einzeln lebend mit russelartigem Kopfanhang."

Labbé regarded the species identical with *Phialoides ornata,* probably because of an identity of hosts rather than a similarity of parasites. A table of the important characteristics of the two species follows, and speaks for itself.

	St. brevirostris	*Ph. ornata*
Epimerite	1/2 length of protomerite	3 x length of protomerite
length	1/8 length of whole sporont	Equal to whole sporont without epimerite
width	1/4 that of protomerite	1/10 that of protomerite
shape	Xipho-conical, i. e. elongate-conoidal, dilated in middle	Cylindrical
apex	Pointed	Flattened, a thickened collar, thickly set with 20 (more or less) small teeth
Protomerite		
shape	Widest at shoulder, tapering to posterior end	Ellipsoidal
where widest	Anterior 1/5	Central region
Posterior extremity	Tapering and pointed	Broadly rounded
Nucleus		
shape	Spherical, several karyosomes	Spherical, several karyosomes.

As noted above, Ellis (1912:25) changed the name of the genus from Stylorhynchus to Stylocephalus, hence this name changes also.

STYLOCEPHALUS GLADIATOR (Blanchard) Watson

1905	*Stylorhynchus gladiator*	Blanchard	1905:923-8
1916	*Stylocephalus gladiator*	Watson	(This paper)

Stylocephalus: Sporonts solitary, elongate, average length 300 to 400μ, maximum length 720μ, width 30μ, maximum width 70μ. Protomerite short, globular. Deutomerite elongate cylindrical, with a slender attenuated posterior extremity, bluntly pointed. Epimerite in two parts, a very long slender cylindrical neck and a dilated xiphoid-shaped apical portion, often longer than the whole gregarine. Nucleus ovoidal with one large karyosome. Cysts not seen.

Taken at Grenoble, France. Host: *Helenophorus collaris* L. Habitat: Intestine.

STYLOCEPHALUS GIGANTEUS Ellis

[Figures 108, 109]

1912	*Stylocephalus giganteus*	Ellis	1912:25-27

Stylocephalus: Sporonts solitary, elongate. Length 1200 to 1800μ. Width not given. Ratio length protomerite : total length :: 1 : 9 to 1 : 18; width protomerite : width deutomerite :: 1 : 1 to 1 : 1.5. Protomerite dome shaped, widest at base or dome shaped, dilated above base, flattened anteriorly. Constriction at septum. Deutomerite widest at shoulder. Cylindrical, terminating in an abrupt but sharply pointed cone. Epimerite a long pointed cone, situated upon a conoidal projection of the protomerite of the cephalont. Endocyte dense. Nucleus not described.

Cysts spherical, 450μ in diameter, entire surface papillated and indented, dehiscence by pseudocyst, spores extruded in chains. Spores irregularly subspherical, black, 7 by 11μ.

Taken at Boulder, and at Denver, Colo. Hosts: *Eleodes* sp.; *Asida opaca* Say; *Asida* sp. and *Eusattus* sp. Habitat: Intestine.

SPHAERORHYNCHUS OPHIOIDES (Schneider) Labbé

1886	*Sphaerocephalus ophioides*	Schneider	1886:100
1899	*Sphaerorhynchus ophioides*	Labbé	1899:32

Sphaerorhynchus: Sporonts solitary, elongate. Length 3 to 4 mm. Epimerite 1/6 the total length of cephalont, consisting of a small spherical or ovoidal body carried on a long cylindrical stalk, broadest at base and gradually narrowing toward apical end. Cephalonts 1.3 mm. long, 220μ of which is length of epimerite and 8.5μ for the terminal sphere.

Taken at ————. Host: *Acis* sp. Habitat: Intestine.

ACANTHOSPORA PILEATA Léger

[Figures 162, 215]

1892	*Acanthospora pileata*	Léger	1892:145-6
1899	*Acanthospora pileata*	Labbé	1899:28

Acanthospora: Sporonts solitary, elongate. Length 300 to 400μ. Ratio length protomerite : total length :: 1 : 6; width protomerite : width deutomerite :: 1 : 1.5. Protomerite nearly hemispherical, little higher than wide, constricted at septum. Deutomerite elongate ellipsoidal, widest just anterior to middle. Endocyte brown. Epimerite a broadly conical papilla. Nucleus ellipsoidal, with several karyosomes.

Cysts spherical, 150 – 180μ in diameter. Spores biconical, ends truncate, with six equatorial spines in a circle. Dimensions 7.5 by 10.5μ.

Taken in the Department of Poitou, France. Hosts: *Cistelides* sp.; *Omoplus* sp. larva (Scudder gives a genus Omophlus, not Omoplus). Habitat: Intestine.

ACANTHOSPORA POLYMORPHA Léger

[Figure 163]

1896	*Acanthospora polymorpha*	Léger	1896 :44-46
1899	*Acanthospora polymorpha*	Labbé	1899 :28

Acanthospora: Sporonts solitary, elongate, polymorphic. Maximum length 1000μ. Protomerite irregularly cylindro-conical. Deutomerite ovoidal, widest through middle. Endocyte yellowish brown.

Cysts 500 to 700μ in diameter. Spores bipyramidal, each face hexagonal, each pole armed with 6 short spines and with a circle of 6 equatorial spines, 8 by 4.4μ.

Taken in Poitou and Tourraine, France. Host: *Hydrous caraboides* (L.) larva. Habitat: Intestine.

ANCYROPHORA GRACILIS Léger

[Figures 122, 164]

18—	*Gregarina acus*	Stein	18— :—
1848	*Actinocephalus Acus*	Frantzius	1848 :195
1863	*Gregarina acus*	Lankester	1863 :95
1892	*Ancyrophora gracilis*	Léger	1892 :146-7

Ancyrophora: Sporonts solitary, elongate. Maximum length 2000μ; maximum width 400μ. Protomerite conical, dilated in central region. Constriction at septum. Deutomerite widest at shoulder, tapering to a long acuminate posterior extremity. Nucleus spherical, with several karyosomes. Epimerite a globular papilla with 8 long backwardly directed flexible 'tentacles'.

Cysts spherical, 200μ in diameter. Spores biconical, truncate, with four spines at each pole and six equatorial spines, 8.5 by 5.1μ.

Taken at ———, Germany, and Poitiers, France. Hosts: *Carabus* sp.; *Carabus auratus* L.; *C. violaceus* L., larvae and adults; and *Silpha thoracica* L. larva.

This species was first described by Stein under the name *Gregarina acus,* according to Léger, but no mention is made of the species in Stein's 1848 article. Frantzius and Lankester refer the species to Stein; Diesing does not mention it.

If the originally described species is the same as the species described by Léger in 1892 under the name *Ancyrophora gracilis,* then the name of the latter should be changed to *A. acus* (Stein) Léger. In the absence, however, of complete data, it stands as given by Léger.

ANCYROPHORA UNCINATA Léger

[Figure 216]

1892	*Ancyrophora uncinata*	Léger	1892:147-8

Ancyrophora: Sporonts solitary, length 150 to 200μ. Width not given. Epimerite garnished with 12 rigid hooks in two alternate rows.

Cysts spherical. Spores spined, both polar and equatorial, 7.5 by 4.5μ.

Taken at Poitiers, France. Hosts: *Dytiscus* sp.; *Colymbetes* sp.; *Sericostoma* sp.; and *Limnophilus rhombicus* (L.) *(Phryganea rhomb.).* Habitat: Intestine.

Labbé placed *Gregarina Dytiscorum* Frantz. with this species under the name of the latter, evidently from a similarity in the first host given above. The species are, however, unlike and I have separated them, listing the former among Uncertain Species, under the Actinocephalidae.

The last three hosts given by Léger are not Coleoptera but Neuroptera and the circumstance of finding the same species of gregarine in such widely separated hosts is unusual and almost unique, yet the record is authentic.

COMETOIDES CAPITATUS (Léger) Labbé

[Figures 123, 124, 165]

1892	*Pogonites capitatus*	Léger	1892:150-1
1899	*Cometoides capitatus*	Labbé	1899:29

Cometoides: Sporonts solitary, elongate. Length 1500μ. Width not given. Ratio length protomerite : total length :: 1 : 13; width protomerite : width deutomerite :: 1 : 1.5. Protomerite subspherical, width equal to height. Constriction at septum. Deutomerite widest at shoulder, tapering from thence to a very long slender bluntly pointed posterior extremity. Epimerite globose, stalked, armed with a subequatorial band of 12 to 15 long slender flexible filaments 32 to 35μ long. Nucleus spherical, with several karyosomes.

Cysts spherical, 300μ in diameter, dehiscence by simple rupture, spores cylindro-biconical, apices truncate, each face octagonal. Poles armed with four spines each, two equatorial rows of spines, spores 2.5 by 5.1μ.

Taken at Poitou and Avanton, France. Host: *Hydrous* sp. larva. Habitat: Intestine.

COMETOIDES CRINITUS (Léger) Labbé

[Figure 125]

1892	*Pogonites crinitus*	Léger	1892:149-50
1899	*Cometoides crinitus*	Labbé	1899:29

Cometoides: Sporonts solitary, very elongate. Maximum length 2000μ. Ratio length protomerite : total length :: 1 : 20; ratio width protomerite : width deutomerite :: 1 : 1.3. Body shaped very similarly to *C. capitatus* except that it is longer. Epimerite hemispherical, flattened surface upward, armed with an equatorial ring of 6 or 8 long slender flexible filaments 100μ long. Endoplasm brown. Nucleus ellipsoidal, with several karyosomes.

Cysts spherical, 200 to 300μ in diameter. Spores cylindro-biconical, spines at the poles and in two equatorial bands.

Taken at Poitou and Vendee, France. Host: *Hydrobius* sp. larva. Habitat: Intestine.

CORYCELLA ARMATA Léger

[Figures 111, 112, 166]

1892	*Corycella armata*	Léger	1892:144-5

Corycella: Sporonts solitary, 280 to 300μ long. Ratio length protomerite : total length :: 1 : 4; width protomerite : width deutomerite :: 1 : 0.9. Protomerite subglobular, constriction at septum, wider in middle than deutomerite. Deutomerite widest at shoulder, tapering thence to a sharp point. Endoplasm gray brown. Epimerite a large globular papilla set upon a stout cylindrical collar which is two-thirds as long as the protomerite itself, and armed with 8 strong short sharply pointed recurved and backwardly directed hooks. Nucleus spherical, containing several karyosomes.

Cysts spherical, 250μ in diameter. Spores biconical, truncate, 4 small spines at each pole, no equatorial spines. 13 by 6.5μ.

Taken at Poitou, France. Host: *Gyrinus natator* (L.) larva. Habitat: Intestine.

HYALOSPORA ROSCOVIANA Schneider

[Figure 129]

1875 *Hyalospora roscoviana* Schneider 1875:584

Hyalospora: Sporonts biassociative, cylindrical, very elongate. Length and width not given. Ratio length protomerite : total length primite :: 1 : 9; width protomerite : width deutomerite :: 1 : 1.6. Protomerite of primite cylindrical, conical, rounded at anterior extremity, twice as high as wide, a constriction at septum. Deutomerite elongate cylindrical, tapering but slightly at posterior end and terminating in a rounded extremity. Nucleus elongate ellipsoidal, with one large karyosome. Epimerite not known. Endocyte yellow to yellow-orange.

Cysts spherical (?), dehiscing by simple rupture. Spores broadly ellipsoidal but sharply pointed.

Taken at Roscoff, France. Host: *Petrobius maritimus.*

The name Petrobius has been applied to genera of both Orthoptera (Thysanura) (1817) and Coleoptera (1836) and, not knowing which one Schneider found as host, I have included this species among the Coleopteran as well as among the Orthopteran parasites. Schneider says of the habitat:

> "Les Petrobius se recontrent, en effet, sur le mur même qui separe le laboratoire de la mer, tapis dans les interstices des pierres. La même espèce est commune sur une grande partie du littoral – – –".

From its habitat, the host might be either an Orthopteran or a Coleopteran.

This is the only species in the genus Hyalospora.

SPHAEROCYSTIS SIMPLEX Léger

[Figure 137]

1892 *Sphaerocystis simplex* Léger 1892:115-16

Sphaerocystis: Sporonts solitary, subspherical, length 100 to 140μ. Width not given. Dicystid, having protomerite only when young. Shape spherical, with a large papillate extension at each end. Nucleus spherical, with a large karyosome.

Cysts spherical, 100μ in diameter, without spore ducts. Encystment solitary. Spores ovoidal, 10.5 by 7.5μ.

Taken at Iteuil (Poitou), France. Host: *Cyphon pallidulus* Boh. *(C. pallidus).* Habitat: Intestine.

EUSPORA FALLAX Schneider

[Figure 131]

1875	*Euspora fallax*	Schneider	1875:583

Euspora: Sporonts biassociative, ellipsoidal. Measurements not given. Ratio length protomerite : total length primite :: 1 : 6; width protomerite : width deutomerite :: 1 : 2.5. Protomerite of primite spherical, deep constriction at septum; deutomerite ellipsoidal, widest through middle or just posterior to middle, posterior end flattened. Nucleus spherical with one karyosome. Endocyte dense except in anterior third of protomerite, where there is a distinct conoidal area of less dense endocyte.

Cysts spherical, dehiscing by simple rupture. Spores prismatic, square cornered, pentagonal in optical view.

Taken at Roscoff, France. Host: A Melolonthid (*Rhizotrogus aes-Asida servillei* Soll. Habitat: Intestine.

HIRMOCYSTIS ASIDAE Léger

1896	*Eirmocystis asidae*	Léger	1896:30
1899	*Hirmocystis asidae*	Labbé	1899:13

Hirmocystis: Sporonts very small, bi- or tri-associative. Cylindrical. Maximum length of association of two, 20μ. Width not given. Ratio length protomerite : total length primite :: 1 : 10 to 1 : 12; width protomerite : width deutomerite :: 1 : 2. Protomerite subglobular, depressed. Deutomerite elongate cylindrical. Epimerite a small simple hyaline papilla. Myocyte well developed. Nucleus spherical with one small karyosome.

Cysts spherical, 70μ, dehiscence by simple rupture. Spores cylindro-ovoidal, 6 by 3.5μ.

Taken at Ain-Fezza, Tlemcen, Province of Oran, Algeria. Host: *Asida servillei* Soll. Habitat: Intestine.

HIRMOCYSTIS HARPALI NOV. SPEC.

[Figures 265, 266, 267, 268, 273, 274]

Host: *Harpalus pennsylvanicus erythropus* (Dej.).

Location Urbana, Illinois, June, 1915.

This species was found very abundant in the intestines of four beetles examined, one containing at least a thousand associations. The sporonts were found in linear associations of twos, threes and fours and each sporont is elongate cylindrical in shape. The maximum length of associations found was 1060μ, maximum length of sporonts 560μ, and maximum width 80μ. Ratio length protomerite : total length :: 1 : 7; ratio width protomerite : width deutomerite :: 1 : 1.2. The protomerite of the primite is dome shaped, a little wider than long and constricted at the septum, but not deeply so. The deutomerite is elongate, seven times as long as the protomerite and well rounded at the posterior end. The protomerite of the satellite is very much flattened, twice as wide as high and not deeply constricted at the septum. The primite fits into a very deep concavity in the protomerite of the satellite (See Fig. 274).

The protoplasm is very dense, black in the deutomerite and much less dense, and tan in color, in the protomerite. The nucleus is spherical and contains one karyosome visible in adults as a clear spot.

The epimerite is large and spherical (Fig. 268). Myonemes are very conspicuous as a horizontal network. Cysts were not seen.

A few measurements are as follows, all dimensions being given in microns:

Total length of associations	1060	910	730
Primite:			
Length protomerite	80	60	60
Length deutomerite	480	440	300
Width protomerite	70	60	50
Width deutomerite	80	90	60
Total length sporont	560	500	360
Ratio			
length protom.: total length	1:7	1:8.3	1:6
width protom.: width deutomerite	1:1.1	1:1.5	1:2
Nucleus, diameter		50	

Satellite:			
Length protomerite	50	40	30
Length deutomerite	450	370	340
Width protomerite	90	50	60
Width deutomerite	80	70	90
Total length sporont	500	410	370
Ratio			
length protom.: total length	1:10	1:10	1:12
width protom.: width deutomerite	1:9	1:1.4	1:1.5

	Length associations of more than two sporonts			
Primite	300	140	120	110
First satellite	170	150	140	100
Second satellite	190	140	70	70
Third satellite		130		
Total length of association	660	560	330	280

This species is very peculiar in that two distinct types of specimens are encountered, viz. large sporonts 500μ long associated in twos (association 1000μ in length), and very small sporonts 100μ long associated in threes and fours. A chain of three of the smaller sporonts seldom exceeds half the length of a chain of two of the larger type. One chain of four small individuals measured only 560μ long.

That the two types of sporonts, however, represent a single species is shown by the following facts: (a) one or two of the smaller sporonts are often attached as satellites to a sporont of the larger type; (b) intermediate sizes are found between the small and the large sporonts; and (c) the small and large sporonts are identical in shape and proportions. Since associations are generally composed entirely of one type of individuals, the difference is not a sexual one.

This species is very similar in shape and proportions and the deep concavity of the protomerite of the satellite to *Gregarina serpentula* de Magalhaes, from *Gryllus domesticus.* The sporonts of the latter occur, however, in twos, while the former occur in threes and fours and it therefore belongs to a different genus entirely.

The species differs considerably from any previously described from the host genus Harpalus. It is differentiated from *Gregarina parva* (Crawley) Watson, *Actinocephalus gimbeli* (Ellis) Watson and *A. harpali* (Crawley) in both measurements and proportions and in the fact that the latter two species are solitary while this one is associative.

GREGARINA CUNEATA Stein

[Figures 132, 133, 134, 135, 136, 152]

1838	*Clepsidrina polymorpha*	Hammerschmidt	1838 :357
1848	*Gregarina cuneata*	Stein	1848 :209-10,222
1848	*Gregarina cuneata*	Frantzius	1848 :196
1851	*Gregarina cuneata*	Diesing	1851 :13
1863	*Gregarina polymorpha*	Lankester	1863 :95
1875	*Clepsidrina polymorpha* var. *cuneata*	Schneider	1875 :581
1899	*Gregarina polymorpha* var. *cuneata*	Labbé	1899 :11
1902	*Gregarina cuneata*	Berndt	1902 :393-404
1903	*Gregarina xylopini*	Crawley	1903 :47
1904	*Gregarina cuneata*	Léger & Duboscq	1904 :354-5
1910	*Clepsidrina cuneata*	Pfeiffer	1910 :108
1911	*Gregarina cuneata*	Ishii	1914 :435
1914	*Gregarina cuneata*	Ishii	1914 :435

Gregarina: Sporonts biassociative, elongate cylindrical. Length 380μ; width 170μ. Ratio length protomerite : total length primite :: 1 : 3; width protomerite : width deutomerite primite :: 1 : 1.5. Protomerite elongate cylindrical, 2½ times as wide as posterior portion, dilated at anterior end, widest part acutely angled, apex broadly rounded. Slight constriction at septum. Deutomerite elongate, width gradually increases from septum to posterior portion, terminates in a very broadly rounded extremity. Nucleus spherical, small, with one karyosome.

Cysts spherical, 240μ in diameter, long spore ducts. Spores extruded in chains, doliform, 5.7 by 4μ.

Taken at Roscoff and Caen, France; Berlin; Philadelphia; and in the province of Izu, Japan. Host: *Tenebrio molitor* L. larv. and adult. Habitat: Intestine.

Hammerschmidt described two gregarines from *Tenebrio molitor* under one name, *Clepsidrina polymorpha*. He regarded them as different shapes assumed by the same parasite.

Stein said, concerning his discoveries:

> "Ich fand drei verschiedend Formen, von denen zwei zur Gattung Gregarina in engern Sinne, eine zur Gattung Stylorhynchus gehort. Hammerschmidt kannte wahrscheinlich bereits zwei Formen, doch geht dies selbst aus seinen Abbildungen die gar zu roh sind, nicht mit volliger Bestimmtheit hervor; er hielt sie aber für eine Art und nannte sie *Clepsidrina polymorpha*."

Stein's figure is reproduced in Figure 133.

Frantzius enumerated among his species both *G. polymorpha* and *G. cuneata* Stein, not recognizing that the former included the latter. He did not illustrate the species *Gregarina cuneata,* but included under the name *G. polymorpha* one excellent figure of *G. cuneata* (Fig. 135). Stein said that Frantzius knew all three gregarines in this Tenebrio, but

> "– – wirt sie ebenfalls zu einer Art unter dem Namen *Gregarina polymorpha* zusammen blos aus dem Grunde, weil sie in einem und demselben Thiere leben."

He named one of the species *Stylorhynchus ovalis.* The other two

> "– – sind einander sehr ahnlich und fast gleich gross. Die eine ist durch den nach vorn erweiterten, flach gedruckten, keilähnlichen Kopf, der fast ⅓ der Lange des Leibes gleichkommt, und durch den nach hinten erweiterten Leib ausgezeichnet; ich nenne sie *Gregarina cuneata.*"

Lankester placed this species and Schneider's *St. ovalis* together as synonyms under the name *Gregarina polymorpha* Hamm. Schneider grouped together under the name *Clepsidrina polymorpha* (Hamm.) the three species from *Tenebrio molitor,* which Stein had separated some twenty-five years before. He designated the species which is under discussion as *Clepsidrina polymorpha* var. *cuneata* (Stein). He considered adult associations of *G. cuneata* as young immature associations of *G. polymorpha.*

> "Les jeunes individus sont nombreux et remarquables par le volume relatif de leur protomerite (Fig. 16 et 17)."

The figure 16 referred to is a typical association of *G. cuneata.* He says further

> "– – Resemble beaucoup à la précédente; est arrondie en arriere au deutomérite et plus massive dans son ensemble (Fig. 11, le primite.)".

His figure 11, my figure 132, coincides with Stein's figure of his *G. cuneata,* my figure 133. Berndt studied the gregarines of the larva of *Tenebrio molitor* and isolated *G. cuneata* from the others. Léger and Duboscq (1904) confirmed his work. (Their drawing is reproduced in my figure 152).

In Leidy's unpublished manuscript, Crawley (1903) found two drawings of gregarines taken from the Tenebrionid, *Xylopinus saperdioides.* One has been otherwise disposed of, but one drawing is of a species identical with or very similar to *G. cuneata.* No description or measurements accompanied the drawings. From a similarity of the figures of the type *G. cuneata* and the figure given by Crawley (my figure 134), the species is the same.

Ishii (1911:279 and 1914:435) found the species in Japan (my figure 36) in *Tribolium ferrugineum,* one of the Tenebrionidae, and very similar to *Tenebrio molitor.* It is quite possible that the parasite is not identical with or a variety of the classic *G. cuneata,* for the figure does not exactly coincide with the others, but no data whatever accompanies the figures and it seems best to leave the species in the present position.

GREGARINA POLYMORPHA (Hammerschmidt) Stein

[Figures 140, 141, 142, 153]

1838	*Clepsidrina polymorpha*	Hammerschmidt	1838:357 ?
1848	*Gregarina polymorpha*	Stein	1848:210,222
1848	*Gregarina polymorpha*	Frantzius	1848:193,195
1851	*Gregarina polymorpha*	Diesing	1851:13
1875	*Clepsidrina polymorpha*	Schneider	1875:580
1899	*Gregarina polymorpha*	Labbé	1899:10
1902	*Gregarina polymorpha*	Berndt	1902:404-8
1904	*Gregarina polymorpha*	Léger and Duboscq	1904:354-7
1910	*Clepsidrina polymorpha*	Pfeiffer	1910:108
1911	*Gregarina polymorpha*	Ishii	1911:279

Gregarina: Sporonts biassociative, elongate, cylindrical, maximum length 350μ, maximum width 100μ. Ratio length protomerite : total length :: 1 : 5 to 1 : 7; width protomerite : width.deutomerite :: 1 : 1.8 to 1 : 2. Protomerite dome shaped, as wide as high, no constriction at septum. Deutomerite elongate cylindrical, rounded at posterior extremity. Nucleus small, spherical, one karyosome.

Cyst and spores unknown.

Taken at Berlin, Germany, and Roscoff and Grenoble, France. Host: *Tenebrio molitor* L. larva and adult. Habitat: Intestine.

Hammerschmidt knew two of the forms of gregarines parasitic in the larvae of *Tenebrio molitor.* He called them, however, by one name. In the words of Stein,

> "Hammerschmidt kannte wahrscheinlich bereits zwei dieser Formen, – –; er hielt sie aber für eine Art und nannte sie *Clepsidrina polymorpha.*"

Stein differentiated the two species, calling one *G. cuneata,* my figure 133, the other *G. polymorpha,* my figure 142.

Frantzius gave, side by side, figures of Stein's *G. cuneata* and *G. polymorpha,* and called them both *G. polymorpha.* (Pl. VII, group V, Figs. 1 and 2; my figures 135 and 140).

Lankester mentioned *G. polymorpha* and under this name gave as synonyms *Stylorhynchus ovalis* Stein and *G. cuneata* Stein.

Schneider brought together again in coincidence with Hammerschmidt's original determination, the three species which Stein had differentiated, and added another variety. He described 1) *Clepsidrina polymorpha* var. *cuneata,* 2) *C. polymorpha typica,* 3) *C. mimosa,* and 4) disposes of *Stylorhynchus ovalis* Stein as

> "– – simplement le céphalin de l'une des varietes que nous allons décrire."

Of these forms, the first has been designated *Gregarina cuneata* Stein; the second remains *Gregarina polymorpha;* the third has been dropped as an authentic species for it is obviously immature and probably from its shape a young individual of *G. cuneata;* the fourth is now *Steinina ovalis* (Stein) Léger and Duboscq.

Berndt separated the species *G. polymorpha* from *G. cuneata,* describing each in detail. Léger and Duboscq corroborated his work and created the genus Steinina for the species previously known as *Stylorhynchus ovalis* Stein. Ishii found the species in Japan, from one of the Tenebrionidae. No description of adults is given.

GREGARINA AMARAE Frantzius

1838	*Clepsidrina ovata*	Hammerschmidt	1838:356
1848	*Gregarina amarae*	Frantzius	1848:195
1851	*Gregarina Amarae*	Diesing	1851:12
1863	*Gregarina Amarae*	Lankester	1863:94
1899	*Gregarina amarae*	Labbé	1899:36

This parasite has not been found since the original discovery of Hammerschmidt. Frantzius mentioned it by name only; Diesing gave this description:

> "Gregarina Amarae Frantzius.
>
> Proboscis – – – Receptaculum ovatum breve. Corpus subglobosum. Longit. 9/40''', crassit – – –
>
> *Clepsidrina ovata* Hamm. (Individua bina postice juncta)". – – –. Habitaculum *Amara cuprea,* in intestinus tenuibus (Hamm.)."

Labbé says that the host is probably the beetle known now as *Poecilus cupreus* (L.).

That this species is a member of the genus Gregarina is attested by Diesing's words ''Individua bina postice juncta'' which indicates the biassociative nature of the sporonts. No drawing accompanies any available mention of the species.

GREGARINA TENUIS Hammerschmidt

1848	*Gregarina tenuis*	Frantzius	1848:195
1851	*Gregarina tenuis*	Diesing	1851:13
1863	*Gregarina tenuis*	Lankester	1863:94

Host: *Allecula* sp.

No mention is made of this species among those in Labbé's Sporozoa or in the list of Sporozoa in Lankester's Treatise (1903). The species is probably a true Gregarina, for Frantzius included in this genus only gregarines "– – stets zu zweien aneinandergeheftet."

He credits the discovery of the species to Hammerschmidt.

GREGARINA ELONGATA Frantzius

[Figure 154]

1848	*Gregarina elongata*	Frantzius	1848:193,195
1851	*Gregarina elongata*	Diesing	1851:13
1863	*Gregarina elongata*	Lankester	1863:94

Host: *Crypticus* sp.

This species is well illustrated by Frantzius. It does not appear in Labbé's Sporozoa.

GREGARINA SCARABAEI Lankester

1851	*Gregarina Scarabaei relicti*	Leidy	1851:208,287
1863	*Gregarina Scarabaei*	Lankester	1863:94

This species is known only from the original description, which is as follows:

> "Body cylindro-fusiform. Superior division presenting four sides of a hexahedron, subacute. Nuclear body of inferior division transparent, globular or elliptical, containing several coarse granules. Length from 1/66 to ¼ lines; head 1/400 in. to 1/133 in. long, by 1/285 in. to 1/111 in. broad. Anterior portion of inferior division 1/200 in. to 1/86 in. broad, posterior division 1/666 in. to 1/250 in. broad. Longitudinal lines of inferior division more distinct than those of upper division, 1/8000 in. apart."

No drawing accompanies the description.

Host: *Scarabaeus relictus* larva.

This species takes the first binomial name applied to it, that of Lankester.

GREGARINA PASSALI Lankester

[Figure 139]

1853	*Gregarina passali cornuti*	Leidy	1853:238
1863	*Gregarina Passali*	Lankester	1863:94
1903	*Gregarina passali cornuti*	Crawley	1903:45
1913	*Gregarina passali cornuti*	Ellis	1913a:201

Gregarina: Sporonts biassociative, cylindrical. Length of associations 350 to 400μ. Width not given. Ratio length protomerite : total length primite :: 1 : 5; width protomerite : width deutomerite :: 1 : 1. Protomerite dome shaped, flattened, 1½ times as wide as high. Slight constriction at septum. Deutomerite cylindrical, sometimes constricted a little in middle. Posterior extremity broadly rounded or flattened. Endocyte opaque; nucleus spherical, content not mentioned.

Taken at Philadelphia, Pa., and New Orleans, La. Host: *Passalus cornutus* Fab. Habitat: Intestine.

Leidy's figure represents sporonts with the deutomerite much wider than long. Crawley's figure is normal. Leidy probably left the animals on the slide in a water medium until they had become greatly distended before drawing them. Ellis recovered the same species from the same Lucanid, from Louisiana.

This species takes the first binomial name, that of Lankester.

The beetles of this host species at Urbana, Illinois, seem to be uninfected. Twenty-five or more have been examined without finding an instance of parasitism with gregarines. They are abundantly supplied with nematodes.

GREGARINA MELOLONTHAE Lankester

1856	*Gregarina Melolonthae Brunneae*	Leidy	1856:47
1863	*Gregarina Melolonthae*	Lankester	1863:94
1913	*Gregarina melolonthaebrunneae*	Ellis	1913b:269

Gregarina: Sporonts biassociative, ellipsoidal. Length of primite 400μ, width 250μ. Ratio length protomerite : total length :: 1 : 4; width protomerite : width deutomerite :: 1 : 1.7. Protomerite oblate spheroidal, slightly elevated at summit. Deutomerite oblong ovoidal. Taken at Philadelphia, Pa.

Host: *Melolontha brunnea.* Habitat: Intestine.

This species has not been redescribed. No drawings accompany Leidy's brief record. Lankester shortened the name to a binomial and it is this name by which the species must be designated. Ellis merely mentions the species.

GREGARINA MUNIERI (Schneider) Labbé

[Figures 128, 147]

1875	*Clepsidrina Munieri*	Schneider	1875:574-8
1899	*Gregarina munieri*	Labbé	1899:9-10

Gregarina: Sporonts biassociative, elongate ellipsoidal. Length and width not given. Ratio length protomerite : total length primite :: 1 : 6 to 1 : 7; width protomerite : width deutomerite :: 1 : 7. Protomerite cylindrical, flattened anteriorly, a little wider than high, less than 1.5 times, slight constriction at septum. Deutomerite cylindrical, ending bluntly or tapering slightly from middle and ending in a broad but rather pointed extremity. Epimerite a small spherical papilla situated upon the apex of a short conical projection of the protomerite of the cephalont. Endocyte reddish orange. Nucleus spherical, with one karyosome.

Cysts ovoidal. Spore ducts 3 to 6, reddish, very short, less than the radius of the cyst in length. Spores extruded in chains, spores barrel shaped, cylindrical, dilated through middle, terminating bluntly.

Taken at Roscoff, France. Hosts: *Timarcha tenebricosa* (F.); *Chrysomela violacea* (Goeze) and *C. haemoptera* L. Habitat: Intestine.

Schneider's argument concerning the species in question speaks for itself and is quoted here (1875:575):

> "'Dans le tube alimentaire de divers Coleoptères, notamment du *Lucanus parallelopipedus,* de plusieurs Mélasomes et de la *Timarcha tenebricosa,* j'ai trouvé abondamment une espèce de Vers intestinaux, dont je joins ici le dessin.' Dufour, 1826. 'L'espèce que j'ai dit habiter des entrailles de divers Coléoptères, mérite, à cause de sa forme, le nom Conica.' Dufour, 1828. Si maintennant on se reporte à la figure indiquée par L. Dufour, on n'y trouve pas la designation de l'hôte de l'individu répresenté; la légende portant simplement cette mention: 'Vers intestinaux trouves dans le tube alimentaire de divers Coleopteres.' Il n'y a donc aucun indice que l'auteur ait plus particulierement visé l'espèce qui nous occupe, et comme il cite d'abord le *Lucanus parallélopipedus,* c'est à la Grégarine de ce Mélolonthide qu'il conviendra de réserver l'épithète de Conica. Quant à l'espèce actuelle, je l'ai dédiée à mon excellent ami M. Munier Chalmas – – –."

The species which Dufour found in *Lucanus parallelopipedus* is the species now named *Actinocephalus conicus* (Dufour) Frantzius.

GREGARINA LAUCOURNETENSIS (Schneider) Labbé

1885	*Clepsidrina Laucournetensis*	Schneider	1885a :28
1899	*Gregarina laucournetensis*	Labbé	1899 :11

Gregarina: Sporonts biassociative, obese. Length 60 to 70μ; width 50 – 60μ. Cysts spherical, one spore duct. Spores elongate ovoidal, extruded in chains.

Taken at ————? Host: *Parnus* sp. Habitat: Intestine.

GREGARINA STATIRAE Frenzel

[Figure 138]

1892	*Gregarina statirae*	Frenzel	1892 :234-82

Sporonts biassociative, spheroidal. Length 300 to 350μ. Width 200μ. Ratio length protomerite : total length primite :: 1 : 5; width protomerite : width deutomerite :: 1 : 3.5. protomerite hemispherical, widest at base, 1.7 times as wide as high. Deutomerite spherical, as wide as high. Nucleus spherical, with one karyosome. Endocyte dense except in anterior third of protomerite, where it is sparse. Epimerite a simple short cylindrical papilla rounded at apex.

Spores and cysts unknown.

Taken at Cordoba, Argentina. Host: *Statira unicolor* Blanch. Habitat: Intestine.

GREGARINA LONGIROSTRIS (Léger) Labbé

[Figure 155]

1892	*Clepsidrina longirostris*	Léger	1892 :122-4
1899	*Gregarina longirostris*	Labbé	1899 :12

Gregarina: Sporonts biassociative, obese. 100μ long. Ratio length protomerite : total length :: 1 : 4; width protomerite : width deutomerite :: 1 : 1.1. Protomerite conoidal, dilated in posterior half. No constriction at septum. Protomerite obovoidal. Nucleus spherical with one karyosome. Epimerite an elongate simple cylinder, 50 – 60μ long, one half or more than half as long as whole cephalont. Endoplasm greenish yellow.

Cysts ovoidal, 60 to 70μ in diameter. One spore duct. Spores barrel shaped, 7.4 by 3.8μ.

Taken in the valley of the Loire, France. Host: *Thanasimus formicarius* (L.). Habitat: Intestine.

GREGARINA ACUTA (Léger) Labbé

[Figure 217]

1892	*Clepsidrina acuta*	Léger	1892:121-2
1899	*Gregarina acuta*	Labbé	1899:11

Gregarina: Sporonts biassociative. Protomerite short, cylindrical, rounded in front. Deutomerite cylindrical, rounded behind. Nucleus spherical, with one karyosome. Epimerite a sharp point.

Cyst and spores unknown.

Taken at Poitou, France. Host: *Trox perlatus* Scriba. Habitat: Intestine.

GREGARINA STEINI Berndt

[Figure 146]

1902	*Gregarina steini*	Berndt	1902:408-13

Gregarina: Sporonts biassociative, 42 to 150μ in length, width 16 to 30μ. Protomerite hemispherical. Constriction at septum. Deutomerite widest at shoulder, tapering to a more or less slender but well rounded posterior extremity. Epimerite a simple globular papilla.

Cysts ovoidal, 70 to 100μ by 85 to 160μ. Cysts smaller than those of *G. cuneata* or *G. polymorpha.*

Taken in Berlin, Germany. Host: *Tenebrio molitor* L. larva. Habitat: Intestine.

The work on this species needs confirmation before it can be accepted absolutely. Léger and Duboscq (1904:351-60) described the gregarines of the larva of this beetle but made no mention of this species. No one of the previous workers on the same beetle has mentioned it. Not knowing how polymorphic *G. polymorpha* may be, the present writer does not wish to comment on this species.

GREGARINA PARVA (Crawley) Watson

[Figure 130]

1903	*Gigaductus parvus*	Crawley	1903a:633-4
1913	*Gigaductus parvus*	Ellis	1913b:271
1916	*Gregarina parva*	Watson	(This paper)

Gregarina: Sporonts biassociative, length 150μ; width 90μ. Ratio length protomerite : total length :: 1 : 5; width protomerite : width deutomerite :: 1 : 1.1 Protomerite subglobular, somewhat flattened anteriorly. Widest through middle portion. Width 1½ times height. Deep constriction at septum. Deutomerite elongate ellipsoidal, widest about or little above middle, terminating bluntly. Nucleus large, spherical, content not noted. Endocyte coarsely granular, not dense.

Cysts 170 to 200μ in diameter, spherical, dehiscence by "one enormous spore duct." Spores cylindrical, 25 by 10μ, square cornered.

Taken at Wyncote, Pa., and Vincennes, Ind. Hosts: *Harpalus caliginosus* Fab. and *H. pennsylvanicus* Dej. Habitat: Intestine.

Crawley created a genus Gigaductus for this species. The genus is described thus:

> "Cysts spherical, with a thin gelatinous envelope. Dehiscence by one enormous spore duct. Maturation period short. Spores cylindrical, very large. Wall single, thick. Spores marked with diagonal lines, those on one side opposed in direction to those on the other, giving the spore a latticed appearance. These lines are apparently due to the sporozoites, which make up a hollow cylinder lying in contact with the inner surface of the spore wall. The residuum, an ellipsoidal mass liberally provided with granules, occupies the cavity of this hollow cylinder."

I have placed the species in question under the genus Gregarina. Several hitherto described species of the genus Gregarina have been recorded to dehisce by one spore duct (e. g. *G. laucournetensis; G. longirostris)*. It is to be noted that sometimes cysts of the genus Gregarina develop only one spore duct and others in the same fecal mass several. There is apparently no maximum-minimum limit to the number of ducts which may be present within the same species.

GREGARINA LUCANI (Crawley) Watson

[Figure 150]

1903	*Euspora lucani*	Crawley	1903:50-1
1916	*Gregarina lucani*	**Watson**	**(This paper)**

Gregarina: Sporonts biassociative, elongate ellipsoidal. Length of associations 880μ. Primite 520μ long, 128μ wide. Ratio length protomerite : total length primite :: 1 : 10; width protomerite : width deutomerite :: 1 : 1.7. Protomerite flattened, widest through middle, twice as wide as high, deep constriction at septum. Deutomerite flattened or broadly rounded behind.

Cyst and spores unknown.

Taken at Swarthmore, Pa. Host: *Lucanus dama* Thunb. Habitat: Intestine.

Ellis (1913a :264) says:

> "This species is referred to the genus Euspora because of the shape of the sporont and the coleopteran host, making the generic determination very uncertain."

The original description gives no evidence that the species is a member of the genus Euspora. The protomerite is not spherical and does not contain the conoidal, less dense area in its anterior third, and the spores are not known and cannot be verified with those of the genus Euspora. The fact that the host is a beetle is of significance since the Eusporae and the Gregarinae are both found in beetles.

I have placed the species in the genus Gregarina because it is associative and does not have characteristics of the other associative genera.

GREGARINA CAVALIERINA Blanchard

1905	*Gregarina cavalierina*	Blanchard	1905 :926-8

Gregarina: Sporonts biassociative, the couple attaining a total length of 1500 to 2000μ. Length primite 500 to 1000μ, width 80 to 100μ. Ratio length protomerite : total length primite :: 1 : 15; width protomerite : width deutomerite? Protomerite flattened, ellipsoidal, longitudinal axis perpendicular to that of deutomerite. Deutomerite cylindrical, rounded hemispherically at posterior end. Endocyte yellow in protomerite, darker in deutomerite. Nucleus spherical, 27μ in diameter, one karyosome.

Cysts spherical, 400μ in diameter, dehiscing by spore ducts 200μ long, 40μ wide at base and 15μ wide at end. Spores extruded in chains. Spores ellipsoidal, 8 by 6μ.

Taken in the mountains of Maure, France. Host: *Dendarus (Pandarus) tristis* Rossi *(=coarcticollis* Mls.). Habitat: Intestine.

GREGARINA SOCIALIS Léger

1906	*Gregarina socialis*	Léger	1906 :323-7
1911	*Gregarina socialis*	Sokolow	1911 :279

Sokolow gives the reference to the original paper by Léger as Arch. Prot. 7 :106-30, but this reference is incorrect. The brief description and text figure are buried in a paper on another species and are not indexed.

Sporonts in chain of 8 to 10 individuals; average size 100μ. Often 3 or 4 small sporonts at posterior extremity. Length protomerite : length deutomerite :: 1 : 5 or 1 : 6.

Host: *Eryx ater* Fabr. larva.

Ellis (1913c:79) refers to this paper as it is given above, but, it is obvious, did not see the paper in question.

GREGARINA GUATEMALENSIS Ellis

[Figure 144]

1912	*Gregarina guatemalensis*	Ellis	1912a:687-8

Gregarina: Sporonts biassociative, the couple attaining 400 to 500μ in length. Width not given. Ratio length protomerite : total length primite :: 1 : 3 to 1 : 3.5; width protomerite : width deutomerite :: 1 : 2.5 to 1 : 7.5. Protomerite subglobose, slightly flattened and pointed at apex, faint constriction at septum. Deutomerite irregularly cylindrical, narrowest at septum, widening very gradually and greatly dilate in posterior fourth, terminating in a very broad flattened extremity, the base nearly twice as wide as the deutomerite at the septum. The whole sporont is shaped like a salt cellar. Sarcocyte very thick, especially in posterior portion of deutomerite. Endocyte of protomerite denser than that of deutomerite. Nucleus spherical, small.

Taken at Quirigua, Guatemala. Host: *Ninus interstitialis* Esch. Habitat: Intestine.

In Ellis' paper (1913b) the host genus is given as Nelus instead of Ninus as in the original description.

GREGARINA GRISEA Ellis

[Figure 151]

1913	*Gregarina grisea*	Ellis	1913a:200-1

Gregarina: Sporonts biassociative, cylindrical. Length of association 500 to 1050μ. Length primite 200 to 500μ. Ratio length protomerite : total length primite :: 1 : 4.5 to 1 : 6.5. Ratio width protomerite : width deutomerite :: 1 : 1 to 1 : 5. Protomerite hemispherical, widest at posterior margin, no constriction at septum. Deutomerite cylindrical, tapering slightly to a broadly rounded posterior extremity. Endocyte dense, dark gray. Nucleus spherical.

Cyst and spores not known.

Taken at New Orleans, La. Host: *Tenebrio castaneus* Knoch. Habitat: Intestine.

GREGARINA MINUTA Ishii

[Figure 143]

1914 *Gregarina minuta* Ishii 1914:436-7

Gregarina: Sporonts biassociative, length of associations 118μ, length primite 58μ. Ratio length protomerite :: total length :: 1 : 9; width protomerite : width deutomerite :: 1 : 1.7. Protomerite somewhat flattened, rounded anteriorly, twice as wide as high. No constriction at septum. Deutomerite cylindrical, broadly rounded at posterior end. Endocyte not dense. Nucleus large, spherical, with one karyosome.

Cysts spherical, 36 by 48μ.

Taken in the province of Izu, Japan. Host: *Tribolium ferrugineum* F. Habitat: Intestine.

Under the name *Gregarina minuta*, the author described two gregarines belonging to widely different families, one, the larger, being a Didymophyes *(D. minuta)*, from the absence of a protomerite in the satellite, and the other the gregarine described above. For a detailed statement of these facts, see article in appendix of this chapter.

GREGARINA KATHERINA Watson

[Figure 171]

1915 *Gregarina katherina* Watson 1915:31

Host: *Coccinella novcmnotata* Herbst.

Location: Oyster Bay, L. I., August, 1914.

Percent of Infection: Fourteen lady beetles of various species were examined and only two found to be parasitized, one with this species, the other with *G. barbarara* Watson. The infection with this gregarine was very heavy, the whole alimentary tract being filled with parasites which numbered into hundreds. The gregarines were practically transparent and it was impossible to count them.

The sporonts are biassociative when adult. The shape is that of a typical gregarine of this genus. The protomerite of the primite is widest at the mass, rounded at its free ends and more or less flattened at the apex. It is 1 1/4 to 1 1/2 times as wide as high, and constricted slightly at the septum. The protomerite of the satellite is flattened top and bottom and three to four times as wide as high. Its upper and lower surfaces are about equal in width. The deutomerite is cylindrical to ellipsoidal from 1-1/2 to two times as wide as is the protomerite; it terminates in a broadly rounded posterior extremity.

Color is practically absent from the animals for the body is almost transparent and contains very little protoplasm in either protomerite or deutomerite. The sporonts were stained with iodine or an anilin dye (safranin in water) before they could be studied.

The nucleus is small and spherical, in diameter attaining only 1/3 to 1/4 the width of the deutomerite. It contains one large karyosome.

Young individuals were seen attached to epithelial cells of the intestine by large smooth sessile transparent epimerites. No cysts were seen.

Movement consists of very slow progression and a still slower contortion of the body.

The character of the epimerite and the biassociative sporonts leaves no doubt that this species belongs to the genus Gregarina. It is differentiated from the other species found in the Coccinellidae by the shape and proportions of the sporonts, especially of the protomerite of the satellite, and by size.

A table of dimensions of a few associations is given here; all dimensions are expressed in microns:

Total length association	96	108	134	141	148
Primite:					
Length protomerite	9	11	10	10	11
Length deutomerite	35	59	52	59	59
Width protomerite	11	17	19	20	14
Width deutomerite	21	30	30	34	30
Total length sporont	44	70	62	69	70
Ratio					
length protom.: total length	1:5	1:1.3	1:6.2	1:6.9	1:6.3
width protom.: width deutom.	1:1.9	1:1.8	1:1.6	1:1.7	1:2.1
Satellite:					
Length protomerite	8	7	8	8	6
Length deutomerite	44	71	64	64	72
Width protomerite	14	26	20	20	21
Width deutomerite	22	35	27	30	23
Total length sporont	53	78	72	72	78
Ratio					
length protom.: total length	1:6.5	1:11	1:9	1:9	1:13
width protom.: width deutom.	1:1.6	1:1.4	1:1.3	1:1.5	1:1.1
Diameter nucleus			9	8	

GREGARINA BARBARA Watson

[Figure 169]

1915	*Gregarina barbarara*	Watson	1915:31

Host: *Coccinella* sp.

Fourteen lady beetles were examined and only two were parasitized, one with this species and the other with the preceding species. Sixteen associations of the present species were found in the one host. The region of infection is the intestine.

The adult sporonts are biassociative. In shape they are similar to other members of this genus. The primite is not essentially different in shape from that of *G. katherina.* The protomerites of the primite in the two species are identical, viz. 1 1/4 to 1 1/2 times as broad as high, cylindrical at the base and terminating in a broadly rounded, often apically flattened anterior extremity. The deutomerite of the primite of this species is more nearly globular, broadening appreciably backwards from the septum and attaining its greatest width in the middle or at the beginning of the posterior two thirds of the body. From here the deutomerite rapidly contracts, ending in a very broadly rounded and not flattened posterior end. The shape of the satellite is quite different from that of the primite. It has the form of an elongated egg smaller at the posterior end. The satellite is generally longer than but is never as wide as the primite. The protomerite is very different from that of *G. katherina.* It is approximately five times as wide as high, and twice as wide as the protomerite of the primite. It is broadly rounded in front and but imperfectly interlocked with the primite. The septum is straight or slightly concave upward, with no constriction whatever at its periphery, the protomerite and deutomerite forming a perfectly smooth contour at the edges of the septum. The deutomerite of the satellite is widest a little behind the septum and anterior to the center of the egg shaped mass. The body gradually tapers from the region of greatest width, ending in a blunt, well rounded extremity.

This parasite is practically transparent with a few large scattered darkly colored protoplasmic granules accumulated in the central regions of the deutomerite of the primite; the satellite is generally free from these dark colored inclusions. The nucleus is rarely obscured by protoplasm; it is small and spherical.

The epicyte is very thin and fragile and the animals quickly break up when exposed to the diluted digestive juices of the host.

A list of the essential measurements with dimensions in microns is appended:

Total length association	283	275	220	192
Primite:				
Length protomerite	17	22	25	20
Length deutomerite	103	113	120	105
Width protomerite	28	40	40	40
Width deutomerite	80	90	90	75
Total length sporont	120	135	145	125
Ratio				
length protom.: total length	1:7	1:6	1:5.8	1:6.2
width protom.: width deutomerite	1:2.5	1:2.2	1:2.2	1:1.9
Satellite:				
Length protomerite	17	10	18	15
Length deutomerite	46	130	57	52
Width protomerite	65	55	60	40
Width deutomerite	80	80	80	68
Ratio				
length protom.: total length	1:9.2	1:14	1:4.2	1:4.5
width protom.: width deutomerite	1:1.2	1:1.4	1:1.3	1:1.7
Diameter nucleus	10			

This species is considerably larger than *Gregarina katherina.*

GREGARINA FRAGILIS Watson

[Figure 175]

1915 *Gregarina fragilis* Watson 1915:32

Host: *Coccinella* sp.

Location: Urbana, Illinois, November, 1914.

The intestine of the host is the seat of infection. Out of thirty or more lady beetles of many species which were examined, only two yielded parasites. About twenty-five associations were found in the two hosts.

The sporonts are biassociative. The protomerite of the primite is cylindrical, rounded at the corners and nearly flattened anteriorly; it is about 1 2/3 times as wide as high. A shallow constriction or none at all is present at the septum. In the satellite, the protomerite is altered slightly in shape, being both flattened and broadened. The deutomerite is subglobular, widest in the middle or slightly posterior to the middle and terminates in a broadly rounded extremity. The satellite is smaller than the primite and less nearly globular in shape.

This parasite is often practically transparent and can only be seen after staining with iodine or a dye in water. The largest specimens contain endocyte tinged with tan color in the deutomerite, while the protomerite is invariably colorless. The nucleus is spherical and small, one third to one fourth the width of the deutomerite in its diameter; it is invisible in vivo and contains one large transparent karyosome.

Trophozoites were seen but the epimerite was not visible because of the transparency when embedded. Cysts are unknown.

Measurements of two associations are as follows; all dimensions are cited in microns:

Total length association	185	208
Primite:		
Length protomerite	20	21
Length deutomerite	80	90
Width protomerite	33	31
Width deutomerite	61	60
Total length sporont	100	111
Ratio		
length protom.: total length	1:5	1:5
width protom.: width deutomerite	1:2	1:2
Satellite:		
Length protomerite	20	20
Length deutomerite	65	77
Width protomerite	33	31
Width deutomerite	43	48
Total length sporont	85	97
Ratio		
length protom.: total length	1:4.2	1:4.8
width protom.: width deutomerite	1:1.3	1:1.5
Diameter nucleus	10	11

This species differs from the other two species described from Coccinellidae in size, shape of the protomerite of the satellite and in color.

GREGARINA TENEBRIONELLA Watson

[Figure 174]

1915 *Gregarina tenebrionella* Watson 1915:32

Host: Larva of an unidentified member of the family Tenebrionidae. Location: Urbana, Illinois, October, 1914.

The intestine of the host was heavily infected, with a hundred or more associations.

The sporonts are biassociative and the shape is that characteristic of this genius. The animals are very small and subglobular. The protomerite of the primite is as wide at the base as throughout the posterior third of the body. Its anterior end is well rounded, without a papilla at the apex. In the satellite, the width of the protomerite is about equal to the height, although it is more or less flattened top and bottom. The length of the protomerite of the primite is one fourth the total length. The deutomerite of the primite is short, broad, globose, widest through the median portion and broadly rounded behind. In the satellite it tapers slightly and is less globular in shape, being one third to four fifths as wide as the deutomerite of the primite. The primite is larger in every instance recorded than the satellite, often longer by one third.

The color of this species is pale gray. The protoplasm is not dense in any part of the body and the protomerite is almost devoid of protoplasm. The granules of the body are not homogeneous, smaller being interspersed with larger. The satellite is more nearly transparent than the primite. The nucleus is spherical, one fourth to one third the width of the deutomerite in its diameter; it is not visible in vivo in the primite but generally so in the satellite. The interlocking device between the sporonts is weakly developed and the individuals often barely touching are easily displaced. Trophozoites and cysts were not seen. Movement consists of a slow uniform progression; contortion was not noted.

A table of measurements follows, in which dimensions are given in microns:

Total length association	140	137	129	109
Primite:				
Length protomerite	17	18	15	16
Length deutomerite	53	53	46	46
Width protomerite	23	20	25	20
Width deutomerite	42	37	38	35
Total length sporont	70	70	61	62
Ratio				
length protom.: total length	1:4.1	1:3.9	1:4	1:3.9
width protom.: width deutomerite	1:1.8	1:1.8	1:1.5	1:1.7

Satellite:				
Length protomerite	13	17	18	10
Length deutomerite	57	50	50	37
Width protomerite	28	20	28	16
Width deutomerite	32	30	50	18
Total length sporont	70	67	68	47
Ratio				
length protom.: total length	1:5.4	1:4	1:3.8	1:4.7
width protom.: width deutomerite	1:1.2	1:1.5	1:1.8	1:1.1
Diameter nucleus	10	8	9	

Shape and size differentiate this species from all the other species found in the Tenebrionidae. For list of these gregarines, see Index of this chapter on Coleopteran parasites.

GREGARINA GRACILIS Watson

[Figure 170]

1915 *Gregarina gracilis* Watson 1915:32

Host: Larva of an unidentified member of the family Elateridae.

Location: Urbana, Illinois, October, 1914.

The parasites infect the intestine of the host.

The sporonts are biassociative. The satellite is generally the larger, contrary to the general rule that either the primite is slightly the larger or the two sporonts differ but little in size. The body is elongate cylindrical, rather longer in proportion than is true of most members of the genus. The protomerite of the primite is hemispherical with no papilla or indentation at the anterior end. The constriction at the septum is shallow; the protomerite is one and one third times as broad as high and averages one sixth the total length of the sporont. The protomerite of the satellite is of practically the same width as that of the primite, but is slightly flattened. The deutomerite is elongate cylindrical, a little wider in the middle portion and tapering slightly, ending in a broadly rounded extremity. The interlocking device is not well constructed, sporonts of an association being barely contiguous and easily dissociated by slight pressure.

The body is pearl gray, and the protoplasm is not homogeneous but consists of large and small granules sparsely scattered throughout. The anterior end of the protomerite is devoid of granules. The nucleus is not visible in adults not because of the density of the protoplasm but because of the fact that the large granules seem to cling to or lie in the region of the nucleus in a cluster. The region occupied by the nucleus can, therefore, be easily detected although its outline is obscured. The nucleus is small and spherical, containing one small karyosome. In one instance, the chromatin was arranged outside the karyosome as in the spokes of a wheel, the karyosome forming the eccentric hub. The epicyte is very thin and of even width throughout.

A table of measurements of sporonts follows; the dimensions are expressed in microns:

Total length association	368	355	310	237
Primite:				
Length protomerite	20	20	21	20
Length deutomerite	158	105	129	97
Width protomerite	35	30	30	23
Width deutomerite	75	50	57	41
Total length sporont	178	125	150	117
Ratio				
length protom.: total length	1:8.9	1:6.2	1:7.1	1:5.8
width protom.: width deutomerite	1:2.1	1:1.7	1:1.9	1:1.9
Satellite:				
Length protomerite	21	20	20	20
Length deutomerite	169	160	140	100
Width protomerite	41	35	35	32
Width deutomerite	80	75	65	45
Total length sporont	190	180	160	120
Ratio				
length protom.: total length	1:9	1:9	1:8	1:6
width protom.: width deutomerite	1:2	1:2.1	1:1.9	1:1.4

GREGARINA INTESTINALIS Watson

[Figure 168]

1915 *Gregarina intestinalis* Watson 1915:32

Host: *Pterostichus stygicus* (Say)

Location: Urbana, Illinois, November, 1914.

A dozen associations were found in the intestine of one beetle. The beetle was also infected with *Gregarina monarchia.*

The sporonts are biassociative. The body is ellipsoidal to subglobose. The protomerite of the primite is subspherical, well rounded in front, widest along the center, equal in width to one fourth to one sixth the width of the deutomerite, and one fifth the total length. There is a fairly deep constriction at the septum. The deutomerite is egg-shaped, widest about the middle portion or slightly posterior to the middle. The posterior end is broadly rounded in the primite and slightly more tapering in the satellite. The individuals of an association are easily detached by slight pressure.

In color, this species is dark and gray, especially in the deutomerite; the protomerite is less dense. The nucleus is not visible in the live animal.

Trophozoites and cysts were not seen.

A table of measurements, in which dimensions are given in microns, follows:

Total length association	320	304		
Primite:				
Length protomerite	40	33	30	35
Length deutomerite	120	137	130	135
Width protomerite	45	42	42	55
Width deutomerite	80	80	70	82
Total length sporont	160	170	150	170
Ratio				
length protom.: total length	1:4	1:5	1:5	1:5
width protom.: width deutomerite	1:2	1:2	1:1.6	1:1.5
Satellite:				
Length protomerite	30	20		
Length deutomerite	130	114		
Width protomerite	50	32		
Width deutomerite	70	75		
Total length sporont	160	134		
Ratio				
length protom.: total length	1:5.3	1:6.7		
width protom.: width deutomerite	1:1.4	1:2.3		

GREGARINA MONARCHIA Watson

[Figure 167]

1915 *Gregarina monarchia* Watson 1915:31

Host: *Pterostichus stygicus* (Say).

Location: Urbana, Illinois, November, 1914.

Only one parasite was seen in the intestine of the host. The same beetle was infected with *Gregarina fragilis.*

The sporonts are biassociative. The body is very long and sausage shaped, easily visible to the eye. The protomerite of the primite is dome shaped, widest just below the middle portion, is but little wider than high, and in length equal to one seventh the total length of the sporont. There is a deep constriction at the septum. The deutomerite is cylindrical, of even width throughout and but little wider than the protomerite. It is broadly rounded at the free extremity. The protomerite of the satellite is flattened top and bottom, twice as wide as high, and in length averages one sixteenth the total length of the satellite. The interlocking device between primite and satellite is deep and well developed.

The body is black, the protoplasm being very dense in all parts except the protomerite of the primite. This portion is nearly transparent except for its lower portion in which the protoplasm is dense and darkly colored. A deep groove runs crosswise just anterior to the middle portion of the protomerite and in front of it is a clear vesicular area rather indistinct in outline. The epicyte is rather thick and of the same width throughout except in the protomerite of the satellite. It is considerably thicker at the place of interlocking and a little thicker on the sides of this protomerite than elsewhere in the association. Trophozoites and cysts were not recovered. Movement of progression was not noted, but a slow contortion was evinced by a slight curving of the body.

Measurements of the one association seen are as follows, with the dimensions stated in microns:

Total length association	1070	
	Primite	Satellite
Length protomerite	80	32
Length deutomerite	490	468
Width protomerite	110	115
Width deutomerite	130	162
Total length sporont	570	500
Ratio		
length protom.: total length	1:7	1:16
width protom.: width deutomerite	1:1.2	1:1.4

GREGARINA GLOBOSA Watson

[Figure 176]

1915 *Gregarina globosa* Watson 1915:31

Host: *Coptotomus interrogatus* (Fab.).

Location: Urbana, Illinois, November, 1914.

The intestine of the host was infected; two beetles out of six examined contained two associations each.

The sporonts are biassociative. The body is subspherical, the protomerite of the primite twice as wide as high and hemispherical but rather flattened at the top. There is a constriction at the septum but it is shallow and scarcely noticeable in the satellite. The deutomerite is stout, three fourths as wide as long; it increases gradually in width up to the beginning of the posterior third of the body, when it becomes rapidly narrower, ending in a very broadly rounded extremity. The protomerite of the satellite is larger than that of the primite, which possibly indicates sexual dimorphism. The primite and satellite are not well interlocked.

The endocyte of the primite is dense and is not visible in vivo. The endocyte of the satellite is paler, revealing the presence of a spherical nucleus. Trophozoite and cysts were not found.

A table of measurements of one association follows in which all dimensions are given in microns:

	Primite	Satellite
Length protomerite	30	45
Length deutomerite	230	165
Width protomerite	75	110
Width deutomerite	180	155
Total length sporont	260	210
Ratio		
length protom.: total length	1:8.6	1:1.4
width protom.: width deutomerite	1:2.4	1:1.4

GREGARINA PLATYNI NOV. SPEC.

[Figures 262, 263, 264]

Host: *Platynus ruficollis* Marsh (Det. Dr. E. P. Felt).

Location: Oyster Bay, L. I., October, 1915.

The host of this species is a very small black beetle which flew in my study window one evening. Several hundred parasites were found in the intestine of the single host.

The sporonts are biassociative. They are elongate cylindrical in shape and generally lie in a slightly curved position. The largest association measured 610μ in length while sporonts averaged 300μ in length and 60μ in width. The average ratio of length protomerite : total length sporont :: 1 : 4.3 and the ratio width protomerite : width deutomerite :: 1 : 1. The protomerite is characterized by a constriction in the middle which is deep and conspicuous in sporonts of all ages and the protoplasm is much less abundant above the constriction than below. There is a deep constriction at the septum between protomerite and deutomerite. The apex of the protomerite is rounded, sometimes rather acutely while the deutomerite is cylindrical, attaining a maximum width just behind the constriction and tapering slightly in the posterior two thirds. The extremity is bluntly rounded. The protomerite of the satellite does not show the constriction which characterizes that of the primite. It is low and flat and slightly wider than long. The constriction at the septum is not as deep here as in the primite. The attachment of the two sporonts of an association is very insecure.

The nucleus is large and spherical, often being in diameter half the width of the deutomerite. It is conspicuous in sporonts of all ages. The protoplasm is very dark in color—often black in the deutomerite but it is not as dense as that of many gregarines. It readily accumulates in masses, leaving clear spaces between. The protomerite is much less dense and tan in color; the portion above the constriction is almost devoid of protoplasm. The epimerite is spherical and very large. Myonemes are large and conspicuous, even in the adults. Movement is active. Cysts were not recovered.

A table of the more important measurements follows with dimensions expressed in microns:

Total length association	610	600	550
Primite:			
Length protomerite	70	70	60
Length deutomerite	230	230	180
Width protomerite	110	60	60
Width deutomerite	110	60	70
Total length sporont	300	300	240
Ratio			
length protom.: total length	1:4.3	1:4.3	1:4
width protom.: width deutomerite	1:1	1:1	1:1.1
Satellite:			
Length protomerite	50	40	50
Length deutomerite	260	260	260
Width protomerite	100	40	70
Width deutomerite	100	70	80
Total length sporont	310	300	310
Ratio			
length protom.: total length	1:6.2	1:7.5	1:6.2
width protom.: width deutomerite	1:1	1:1.7	1:1.1

This species is almost unique in the possession of a deep constricting groove in the protomerite of the primite. This feature, together with the long cylindrical deutomerite, readily differentiates it from other species.

UNCERTAIN SPECIES IN THE GENUS GREGARINA

GREGARINA ELATERAE Crawley

[Figure 158]

1903	*Gregarina elaterae*	Crawley	1903:46

Sporonts not seen. Crawley's description is based evidently on the cephalonts and a species can hardly be assigned to material containing no mature specimens for the cephalonts of many of the Gregarinidae are identical. Crawley's description is in part as follows:

> "Epimerite spherical, protomerite elliptical, long axis perperdicular to that of deutomerite, sharp constriction at septum. Deutomerite oval to subspherical. Endocyte characteristic of cephalonts, sparse and granular. Max. length 62μ. Host *Elater* sp, larva. Taken at Wyncote, Pa."

The species is probably a member of the genus Gregarina from the epimerite, but it cannot stand as absolute. Subsequent discovery of the sporonts probably cannot be correlated with the cephalonts here described owing to a similarity of the cephalonts of so many species.

GREGARINA CURVATA (Frantzius) Diesing

1838	*Rhizinia* sp.	Hammerschmidt	1838:356
1848	*Sporadina curvata*	Frantzius	1848:195
1851	*Gregarina curvata*	Diesing	1851:14
1863	*Gregarina curvata*	Lankester	1863:94

The following and only description of the species available is quoted from Diesing:

> "Proboscis ? . Receptaculum rotundatum. Corpus elongatum retrorsum attenuatum curvatum, receptaculo sexies longius. Longit. ⅛ - ¾'''."

Host: *Cetonia aurata* larv. Habitat: Intestine.

Frantzius merely names the species, giving neither drawing nor description. Diesing gives no clue as to whether the species is biassociative or not. Lankester places it in the genus Gregarina, which he characterizes by the phrase "two animals frequently hanging together" giving no description. The species has not since been mentioned in the literature, and in lieu of complete data, it is placed in the group of doubtful species under the genus Gregarina.

UNCERTAIN SPECIES OF UNCERTAIN FAMILIES

GREGARINA BOLETOPHAGI Crawley

[Figure 145]

1903	*Gregarina boletophagi*	Crawley	1903-47-8

Sporonts not associative, cylindrical, 320μ in length.

> "Protomerite large, variable in shape. Separated from deutomerite by a sharp constriction. Deutomerite cylindrical, with – – conical end. – – Endocyte dense, – – nucleus oval to spherical, with one karyosome. Epimerite not seen. Host: *Boletophagus cornutus.* Locality Swarthmore, Pa."

Ellis (1913b:280) says

> "This species has been transferred to this genus (Anthorhynchus) from Gregarina although neither cysts nor epimerite are known, because it is not found in association and because the anterior portion of the protomerite is suggestive of the slightly produced protomerite of other species of the genus Anthorhynchus which bear epimerites. It is to be regarded as a provisional determination only."

No characteristics of the genus Anthorhynchus are evident. The epimerite, not being seen, cannot be compared with the very large globular epimerite of the latter genus and the spores cannot be compared, not being seen. The size of the species in question is only one seventh that of the type species of the genus Anthorhynchus *(A. sophiae* Schn.).

It seems that the only solution of the problem is the relegation of the species to the uncertain group.

GREGARINA MICROCEPHALA Leidy

[Figure 149]

1889	*Gregarina microcephala*	Leidy	1889:11

''Body clavate, the head like a watch crystal with a little ball at the summit.'' Length 350μ, width 100μ, head 12μ long x 40μ wide.

Taken at Philadelphia, Pa. Host: *Arrhenoplita bicornis* Olivier *(Hoplocephalus bi.)*. Habitat: Intestine.

Ellis (1913b) corrected the host name. He left the species in the genus Gregarina. Leidy said of the species:

> "It bears a close resemblance to *Echinocephalus hispidis* Schneider – – but in the one described I at no time found digitiform appendages on the head."

That the species belongs in the genus Gregarina seems doubtful; its position is left undetermined.

GREGARINA OVALIS (Crawley) Watson

[Figures 156, 157]

1903	*Hirmocystis ovalis*	Crawley	1903 :50
1913	*Gregarina elaterae*	Ellis	1913b :270
1916	*Gregarina ovalis*	Watson	(This paper)

Sporonts cylindrical, 70µ long, width not given. Ratio length protomerite : total length :: 1 : 4; width protomerite : width deutomerite :: 1 : 1.1 Protomerite hemispherical, widest at base. Slight constriction at septum. Deutomerite dilated at shoulder, cylindrical, ending very bluntly. Endocyte dark brown. Anterior third of protomerite free from granules. Nucleus not seen.

Cyst and spores unknown.

Taken at Wyncote, Pa. Host: Cucujidae larva (''doubtful det.''). Habitat: Intestine.

This species is probably associative but adult sporonts have not been found. The specimens illustrated are probably mature. The length is less than in most adult gregarines.

Ellis placed the species and Crawley's *Gregarina elaterae* together under the name of the latter. I have rather regarded the latter species as a doubtful one and have left this gregarine under its original name but questioning the correctness of the genus name. The species cannot be assigned to the genus Gregarina without a question of doubt arising. It is therefore placed with the uncertain species.

GREGARINA COPTOTOMI NOV. SPEC.

[Figure 172]

Host: *Coptotomus interrogatus* (Fab.). Location: Urbana, Illinois, November, 1914.

Two hosts each contained one parasite in the intestine.

The sporonts are solitary. In shape the body is elongate ellipsoidal. The protomerite is cylindrical at the base with a broadly rounded conical apex; it is as wide as high and the widest part is just anterior to the septum. There is no constriction at the septum. The deutomerite is elongate ellipsoidal broadening rapidly from the septum and soon attaining its maximum width. It remains of the same width throughout most of the length, terminating in a very broadly rounded blunt extremity. The endocyte is gray and not dense, for the nucleus is clearly visible in vivo as an ellipsoidal body twice as long as wide and containing one large karyosome. Trophozoites and cysts have not been observed.

Measurements are as follows with dimensions given in microns:

Total length sporont	210	125
Length protomerite	30	18
Length deutomerite	180	107
Width protomerite	35	28
Width deutomerite	80	38
Ratio		
length protom.: total length	1:7	1:7
width protom.: width deutomerite	1:2.3	1:1.3
Nucleus	41 by 20	23 by 10

It is very probable that these specimens are not members of the genus Gregarina. The ellipsoidal nucleus is like that of some of the Actinocephalidae. No attempt is made to place the specimens, and they are mentioned for the completeness of the record only.

STYLOCEPHALUS sp.

[Figure 65]

?1875 *Stylocephalus longicollis* Schneider 1875: Pl. xix, fig. 2

The following description is copied from Crawley (1903:47):

> "*Gregarina xylopini* Crawley.
>
> The two gregarines shown in figures 29 and 30 are stated by Leidy to be parasites of the beetle *Xylopinus saperdioides*. Of the six beetles examined, five contained gregarines of the form shown in figure 29, one of the form shown in figure 30. These two forms are so dissimilar that it appears better, at present, to give only the figures, reserving the description until additional information is at hand."

Figure 29 is reproduced in my figure 65; figure 30 in my figure 134. The first gregarine agrees in appearance with sporonts of Schneider.

Ellis considers it as synonymous with his *Actinocephalus zophus*. I do not, however, regard it as such, but as a separate species. See discussion under *A. zophus*.

The second gregarine, (Figure 134) is evidently a specimen of *Gregarina cuneata*. The host is one of the Tenebrionidae and the drawing compares very favorably with the others listed under *G. cuneata* Stein.

GREGARINA sp. Crawley

[Figure 105]

"*Asterophora philica* Crawley. *Gregarina philica* Leidy (1889). It is impossible to give a description of this species. Figures 31 and 32 are very plainly of the same gregarine, whereas figure 33 seems almost certainly to belong to a different species. Further, the form figured by Leidy in 1889 is not so closely like that shown in figures 31 and 32 as to render it certain that the two are the same. I therefore include the three different forms under the same name, giving only the figures and reference, until such time as sufficient material is obtained to determine accurately what the actual facts may be.

The gregarines figured were about 300 microns long."

(Crawley, 1903:53).

The first two gregarines have been described under the name *Asterophora philica* (Leidy) Crawley. The third is certainly very different from the others and merits isolation. Its generic position is undetermined from lack of data and it is mentioned here simply for completeness of the record.

APPENDIX

AN UNNAMED DIDYMOPHYES FROM A JAPANESE BEETLE

In a recent article on the parasites in the intestine of a Japanese beetle, *Tribolium ferrugineum* F., (Tenebrionidae), S. Ishii (1914) has evidently confused two species of Polycystid Gregarines and designated them by the same name. He described two kinds of associations, large and small, as *Gregarina minuta*, but from his drawings and measurements the specimens are unlike. The protomerite of the primite in the first (Fig. 71) is large, subglobose, nearly flattened on the anterior surface, five eighths as wide as the deutomerite at its widest portion, and three fifths as high as wide. Its widest portion is some little distance anterior to the septum. At the septum, there is a deep constriction, the protomerite just anterior to it being wider than the deutomerite just posterior to it. In figure 143, the protomerite of the primite is smaller in proportion than in figure 71, hemispherical in shape, widest on its posterior margin, two thirds as wide as the deutomerite at its widest part, and half as high as broad. It is narrower at the septum than is the deutomerite just posterior to the septum. Thus there is a smooth, rounded contour along the edge of the septum. The length given for the larger associations is 188μ, for the smaller 118μ.

In his general description, Ishii says ''the protomerite in the satellite is not infrequently hidden from view, being entirely embedded in the deutomerite of the primite.''* In his table of measurements, he says of the satellite ''protomerite absent.'' Later he mentions ''the frequent absence of protomerite in the satellite.'' The figure of the larger association (Fig. 71) lacks a protomerite in the satellite; the figure of the smaller (Figure 143) shows a protomerite and the table of measurements corroborates its presence.

Absence of protomerite in the satellite is not one of the diagnostic features of the genus Gregarina. If the protomerite had been absent in rare instances, the sporont might have been a ''sport'', but its frequent absence is, clearly enough, reason for removing the specimens from the genus Gregarina.

Absence of the protomerite of the satellite is the chief diagnostic character of the family Didymophyidae, in which there is but one genus, Didymophyes, and of this family only. Therefore this polycystid gregarine which lacks a protomerite in the satellite belongs to the latter genus and I have (p. 133) designated it *Didymophyes minuta* (Ishii). Of course, the determination cannot be absolute without the spores and epimerite, but if the specimens belong to any known genus, they must belong to the genus Didymophyes.

Of the four hitherto described species in this genus, two have been recovered from Coleoptera. The present species is the smallest to be recorded, by 67μ. *(D. longissima* Sieb.).

The smaller associations which Ishii described and in which the protomerite of the satellite is present, belong, without doubt, to the genus Gregarina, and the name *G. minuta* refers to them only.

There is also either a confusion of species or an error in observation in regard to the species *Gregarina crassa* (Ishii, 1914:438). He illustrates but one specimen and, in this one indistinct figure, it is impossible to determine whether or not there is a protomerite in the satellite. Since only one specimen is measured and but one drawn, no comparisons can be made between the specimens with and those without protomerites in the satellites and I am unable to determine the number of species under consideration and the systematic position of the specimen described.

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*This statement is construed to mean that the author did not see the protomerite of the satellite and inferred that it was embedded in the deutomerite of the primite.

PART IV

THE CEPHALINE GREGARINES OF THE WORLD

TOGETHER WITH THEIR HOSTS

Parasite	Host	Order or Class
DIDYMOPHYIDAE		
Didymophyes gigantea	*Oryctes nasicornis* (L.)	Coleoptera
	Oryctes sp.	
	Phyllognathus sp.	
leuckarti	*Aphodius prodromus* (Brahm.)	Coleoptera
	Aphodius nitidulus F.	
longissima	*Gammarus pulex* (L.)	Crustacea
	Orchestia littorea Leach	
minuta	*Tribolium ferrugineum* F.	Coleoptera
paradoxa	*Geotrupes stercorarius* (L.)	Coleoptera
GREGARINIDAE		
Gregarina achetaeabbreviatae	*Gryllus abbreviatus* Serv.	Orthoptera
acridiorum	*Pamphagus* sp.	
	Tryxalis sp.	
	Sphingonotus sp.	Orthoptera
acuta	*Trox perlatus* Scriba	Coleoptera
amarae	*Poecilus cupreus* (L.)	Coleoptera
barbarara	*Coccinella* sp.	Coleoptera
blattarum	*Periplaneta americana* (L.)	Orthoptera
	Periplaneta orientalis (L.)	Orthoptera
	Blattella germanica (L.)	Orthoptera
boletophagi	*Boletophagus cornutus* Panz.	Coleoptera
cavalierina	*Dendarus tristis* Rossi	Coleoptera
clausi	*Phronima* sp.	Crustacea
conica	Coleoptera and Orthoptera	
consobrina	*Ceuthophilus valgus* Scud.	Orthoptera
coptotomi	*Coptotomus interrogatus* (Fab.)	Coleoptera
cuneata	*Tenebrio molitor* L.	Coleoptera
curvata	*Cetonia aurata* L.	Coleoptera
davini	*Gryllomorpha dalmatina* Ocsk.	Orthoptera
elaterae	*Elater* sp.	Coleoptera
elongata	*Crypticus* sp.	Coleoptera
ensiformis	*Salpa aeruginosa*	Tunicata
flava	*Salpa confoederata*	Tunicata
	Salpa vagina	Tunicata
fragilis	*Coccinella* sp.	Coleoptera
galliveri	*Gryllus abbreviatus* Serv.	Orthoptera
gammari	*Gammarus* sp.	Crustacea
globosa	*Coptotomus interrogatus* (Fab.)	Coleoptera

Parasite	Host	Order or Class
gracilis	*Elater* sp.	Coleoptera
granulosa	*Ephemera* sp.	Neuroptera
grisea	*Tenebrio castaneus* Knoch	Coleoptera
guatemalensis	*Ninus interstitialis* Esch.	Coleoptera
hyalocephala	*Tridactylus variegatus* Latr.	Orthoptera
illinensis	*Ischnoptera pennsylvanica* (deGeer)	Orthoptera
intestinalis	*Pterostichus stygicus* (Say)	Coleoptera
katherina	*Coccinella novemnotata* Herbst	Coleoptera
kingi	*Gryllus abbreviatus* Serv.	Orthoptera
lagenoides	*Lepisma saccharina* L.	Thysanura
laucournetensis	*Parnus* sp.	Coleoptera
locustae	*Dissosteira carolina* L.	Orthoptera
longa	*Tipula* sp.	Diptera
longiducta	*Ceuthophilus maculatus* (Say)	Orthoptera
	Ceuthophilus latens Scud.	Orthoptera
longirostris	*Thanasinius formicarius* (L.)	Coleoptera
lucani	*Lucanus dama* Thunb.	Coleoptera
macrocephala	*Nemobius sylvestris* (F.)	Orthoptera
	Gryllus domesticus L.	Orthoptera
marteli	*Embia* sp.	Neuroptera
melolonthae	*Melolontha brunnea* Blanch.	Coleoptera
microcephala	*Arrhenoplita bicornis* Oliv.	Coleoptera
millaria	*Gammarus* sp.	Crustacea
	Astacus sp.	Crustacea
minuta	*Tribolium ferrugineum* F.	Coleoptera
monarchia	*Pterostichus stygicus* (Say)	Coleoptera
munieri	*Timarcha tenebricosa* (F.)	Coleoptera
	Chrysomela violacea (Goeze)	Coleoptera
	Chrysomela haemoptera L.	Coleoptera
mystacidorum	*Mystacida* sp.	Neuroptera
nereidis denticulata	?	Annelida
nigra	Acridiidae	Orthoptera
oblonga	*Oedipoda migratoria* L.	Orthoptera
	Oedipoda stridula L.	
	Gryllus campestris L.	Orthoptera
ovalis	Cucujidae	Coleoptera
ovata	*Forficula auricularia* L.	Orthoptera
oviceps	*Gryllus abbreviatus* Serv.	Orthoptera
	Gryllus americanus Blatch.	
panchlorae	*Panchlora exoleta* Klug	Orthoptera
paranensis	*Schistocerca paranensis* Burm.	Orthoptera
parva	*Harpalus caliginous* Fab.	Coleoptera
	Harpalus pennsylvanicus Dej.	
passali	*Passalus cornutus* Fab.	Coleoptera

Parasite	Host	Order or Class
platyni	*Platynus ruficollis* Marsh	Coleoptera
podurae	*Orchesella villosa*	Thysanura
polymorpha	*Tenebrio molitor* L.	Coleoptera
praemorsa	*Platycarcinus* sp.	Crustacea
psocorum	*Psocus* sp.	Neuroptera
pterotracheae	*Pterotrachea* sp.	Mollusca
rigida	Acridiidae	Orthoptera
salpae	*Salpa maxima*	Tunicata
scarabaei	*Scarabaeus relictus*	Coleoptera
serpentula	*Periplaneta orientalis* (L.)	Orthoptera
socialis	*Eryx ater* Fab.	Coleoptera
soror	uncertain	Coleoptera
sphaerulosa	*Gryllotalpa* sp.	Locustidae
statirae	*Statira unicolor* Blanch.	Coleoptera
steini	*Tenebrio molitor* L.	Coleoptera
stygia	*Ceuthophilus stygius* (Scud.)	Orthoptera
tenebrionella	Tenebrionidae	Coleoptera
tenuis	*Allecula* sp.	Coleoptera
termitis	*Termes* sp.	Neuroptera
tipula	*Tipula* sp.	Diptera
udeopsyllae	*Udeopsylla nigra*	Locustidae
valettei	*Pollicipes* sp.	Crustacea
sp. (Bolsius)	*Glossiphonia* sp. *Herpobdella* sp.	Annelida
sp. (Crawley)	*Nyctobates pennsylvanica* (deGeer)	Coleoptera
sp. (Gaede)	*Blaps mortisaga* L.	Coleoptera
sp. (Hallez)	*Dendrocoelum lacteum*	Platyhelminthes
sp. (Kölliker)	*Balanus* sp.	Crustacea
sp. (Mawrodiadi)	*Balanus* sp.	Crustacea
sp. (Moseley)	*Peripatus* sp.	Onycophora
sp. (Pfeiffer)	*Gammarus pulex*	Crustacea
sp. (Porter)	*Rhynchobolus americanus*	Annelida
sp. (Ritter)	*Perophora annectens*	Tunicata
sp. (Solger)	*Balanus improvisus*	Crustacea
Hirmocystis asidae	*Asida servillei* Sol.	Coleoptera
gryllotalpae	*Gryllotalpa gryllotalpa* (L.)	Orthoptera
harpali	*Harpalus pennsylvanicus erythropus* (Dej.)	Coleoptera
polymorpha	*Limnobia* sp.	Diptera
ventricosa	*Tipula* sp. *Pachyrhina* sp.	Diptera Diptera
Sphaerocystis simplex	*Cyphon pallidulus* Boh.	Coleoptera
Hyalospora affinis	*Machilis cylindrica* Geoff.	Thysanura
reduvii	*Reduvius personatus* L.	Hemiptera

Parasite	Host	Order or Class
roscoviana	*Perobius maritimus* Leach	Thysanura
Cnemidospora lutea	*Glomeris* sp.	Myriapoda
Euspora fallax	*Rhizotrogus aestivus* Oliv.	Coleoptera
Gamocystis ephemerae	*Ephemera* sp.	Neuroptera
tenax	*Blattella lapponica* L.	Orthoptera
Frenzelina chtamali	*Chtamalus stellatus*	Crustacea
conformis	*Pachygraspus marmoratus*	Crustacea
delphinia	*Talorchestia longicornis*	Crustacea
dromiae	*Dromia dromia*	Crustacea
fossor	*Pinnotheres pisum*	Crustacea
nigrofusca	*Uca pugnax* and *Uca pugilator*	Crustacea
ocellata	*Eupagurus prideauxi*	Crustacea
olivia	*Libinia dubia*	Crustacea
portunidarum	*Portunus arcuatus*	Crustacea
praemorsa	*Cancer pagurus*	Crustacea
Uradiophora communis	*Balanus* sp.	Crustacea
cuenoti	*Atyaephyra desmaresti*	Crustacea
Leidyana erratica	*Gryllus abbreviatus* Serv. *Gryllus pennsylvanicus* Burm.	Orthoptera
gryllorum	*Gryllus domesticus* (L.)	Orthoptera
DACTYLOPHORIDAE		
Dactylophorus robustus	*Cryptops hortensis* Leach *Cryptops anomalons lusitanus* Verh.	Myriapoda
Nina giardi	*Scolopendra oraniensis*	Myriapoda
giardi corsicum	*Scolopendra oraniensis lusitanica* Verh.	Myriapoda
gracilis	*Scolopendra cingulata* (Latr.)	Myriapoda
indicia	*Scolopendra subspinipes* Leach	Myriapoda
Trichorhynchus pulcher	*Scutigera* sp.	Myriapoda
	Scutigera forceps (Raf.)	Myriapoda
Echinomera hispida	*Lithobius forficatus* Linn.	Myriapoda
	Lithobius coloradensis Cock.	Myriapoda
horrida	*Lithobius calcaratus* Koch	Myriapoda
Rhopalonia geophili	*Himantarium gabrielis* Linn.	Myriapoda
	Stigmatogaster gracilis Mein.	Myriapoda
stella	*Himantarium gabrielis* Linn.	Myriapoda
Acutispora macrocephala	*Lithobius forficatus* Linn.	Myriapoda
Metamera schubergi	*Hirudinea* sp.	Annelida
ACTINOCEPHALIDAE		
Actinocephalus acutispora	*Silpha laevigata* F.	Coleoptera
americanus	*Galerita bicolor* Drury	Coleoptera
brachydactylus	*Aeshna* sp.	Neuroptera
caudatus	*Sciara* sp.	Diptera
conicus	*Dorcus parallelopipedus* (L.)	Coleoptera

Parasite	Host	Order or Class
crassus	*Leptochirus edax* Sharp	Coleoptera
dicaeli	*Dicaelus ovalis* Lec.	Coleoptera
digitatus	*Chlaenius vestitus* (Payk.)	Coleoptera
dujardini	*Lithobius forficatus* L.	Myriapoda
dytiscorum	*Dytiscus* sp.	Coleoptera
fimbriatus	*Dissosteira carolina* L.	Coleoptera
gimbeli	*Harpalus pennsylvanicus* Dej.	Coleoptera
harpali	*Harpalus caliginosus* Fab.	Coleoptera
octacanthus	*Phryganea* sp.	Neuroptera
repelini	*Phalangium* sp.	Arachnida
sieboldi	*Agrion* sp.	Neuroptera
stelliformis	*Ocypus olens* (Mull.)	Coleoptera
	Carabus auratus L.	Coleoptera
	Carabus violaceus L.	
	Rhizotrogus sp.	
striatus	*Scolopendra cingulata* (Latr.)	Myriapoda
tipulae	*Tipula* sp.	Diptera
zophus	*Nyctobates barbata* Knoch	Coleoptera
	Nyctobates pennsylvanica (deGeer)	Coleoptera
sp.	*Ctenophora* sp.	Diptera
Geniorhynchus aeschna	*Aeschna constricta* Say	Neuroptera
monnieri	*Libellules* sp.	Neuroptera
Phialoides ornator	*Hydrophilus piceus* (L.)	Coleoptera
Pyxinia crystalligera	*Dermestes vulpinus* Fabr.	Coleoptera
	Dermestes peruvianus Casteln.	
frenzeli	*Attagenus pellio* L.	Coleoptera
möbuszi	*Anthrenus verbasci* Oliv.	Coleoptera
rubecula	*Dermestes lardarius* L.	Coleoptera
	Dermestes vulpinus Fabr.	Coleoptera
Beloides firmus	*Dermestes lardarius* L.	Coleoptera
tenuis	*Dermestes undulatus* Brahm.	Coleoptera
Legeria agilis	*Colymbetes* sp.	Coleoptera
Coleorhynchus heros	*Nepa* sp.	Hemiptera
Bothriopsis histrio	*Dytiscus* sp.	Coleoptera
	Hydaticus cinereus L.	
	Colymbetes fuscus L.	
	Acilius sulcatus L.	
terpsichorella	*Hydrophilus* sp.	Coleoptera
Asterophora cratoparis	*Cratoparis lunatus* Fab.	Neuroptera
elegans	*Phryganea* sp.	Neuroptera
mucronata	*Rhyacophila* sp.	Neuroptera
philica	*Nyctobates pennsylvanica* (deGeer)	Coleoptera
Schneideria mucronata	*Bibio* sp.	Diptera
Stictospora provincialis	*Melolontha* sp.	Coleoptera
	Rhizotrogus sp.	

Parasite	Host	Order or Class
Stylocystis ensifera	*Leptochirus edax* Sh.	Coleoptera
praecox	*Tanypus* sp.	Diptera
Steinina harpali	*Harpalus pennsylvanicus longior* (Kirby)	Coleoptera
obconica	*Tribolium ferrugineum* F.	Coleoptera
ovalis	*Tenebrio molitor* L.	Coleoptera
rotunda	*Amara angustata* Say	Coleoptera
Taeniocystis truncata	*Sericostoma*	Neuroptera
Amphoroides calverti	*Callipus lactarius* (Say)	Myriapoda
	Lysiopetalum lactarium (Say)	Myriapoda
polydesmi	*Polydesmus complanatus* (L.)	Myriapoda
	Polydesmus dispar Silvestri	Myriapoda
Pileocephalus bergi	*Necrobia ruficollis* Fabr.	Coleoptera
blaberae	*Blabera claraziana* Sauss.	Orthoptera
chinensis	*Mystacides* sp.	Neuroptera
Anthorhynchus sophiae	*Phalangida* sp.	Arachnida
fissidens	*Phalangides* sp.	Arachnida
goronowitschi	*Phalangium* sp.	Arachnida
Sciadophora phalangii	*Phalangium* sp.	Arachnida
Hoplorhynchus actinotus	*Scolopocryptops sexspinosus* (Say)	Myriapoda
	Scolopocryptops sp.	
scolopendras	*Scolopendra woodi* Mein.	Myriapoda
Amphorocephalus amphorellus	*Scolopendra heros* Giard	Myriapoda
ACANTHOSPORIDAE		
Acanthospora pileata	*Omoplus* sp.	Coleoptera
	Cistelides sp.	Neuroptera
polymorpha	*Hydrous caraboides* (L.)	Coleoptera
Corycella armata	*Gyrinus natator* (L.)	Coleoptera
Ancyrophora gracilis	*Carabus* sp.	Coleoptera
	Carabus auratus L.	
	Carabus violaceus L.	
	Silpha thoracica L.	Coleoptera
uncinata	*Dytiscus* sp.	Coleoptera
	Colymbetes sp.	
	Sericostoma sp.	
	Limnophilus rhombicus (L.)	Neuroptera
Cometoides capitatus	*Hydrous* sp.	Coleoptera
crinitus	*Hydrobius* sp.	Coleoptera
MENOSPORIDAE		
Menospora polyacantha	*Agrion* sp.	Neuroptera
STYLOCEPHALIDAE		
Stylocephalus balani	*Balanus* sp.	Crustacea
brevirostris	*Hydrophilus* sp.	Coleoptera
caudatus	*Phalangides* sp.	Arachnida
giganteus	*Eleodes* sp.	Coleoptera
	Eusattus sp.	

Parasite	Host	Order or Class
	Asida opaca Say	
	Asida sp.	Coleoptera
gladiator	*Helenophorus collaris* L.	Coleoptera
heeri	*Phryganea* sp.	Neuroptera
longicollis	*Blaps mortisaga* L.	Coleoptera
oblongatus	*Opatrum sabulosum* (L.)	Coleoptera
	Asida grisea (F.)	
oligacanthus	*Agrion* sp.	Neuroptera
phallusiae	*Phallusia* sp.	Mollusca
sp.	*Xylopinus saperdioides* Oliv.	Coleoptera
Sphaerorhynchus ophioides	*Acis* sp.	Coleoptera
Lophocephalus insignis	*Helops striatus* Geoff.	Coleoptera
Cystocephalus algerianus	*Pimelia* sp.	Coleoptera
Oocephalus hispanus	*Morica* sp.	Coleoptera
STENOPHORIDAE		
Stenophora aculeata	*Craspedosoma rawlinsii* Verh.	Myriapoda
brölemanni	*Blaniulus hirsutus* Bröl.	Myriapoda
	Brachyiulus superus Latzel	Myriapoda
	Brachyiulus pusillus lusitanus Verh.	Myriapoda
chordeume	*Chordeuma silvestre* C. Koch	Myriapoda
cockerellae	*Parajulus* sp.	Myriapoda
corsica	*Craspedosoma legeri* Bröl.	Myriapoda
dauphinia	*Julus mediterraneus* Latzel	Myriapoda
	Julus boleti C. Koch	Myriapoda
	Julus fallax Meinert	Myriapoda
diplocorpa	*Euryurus erythropygus* (Brandt)	Myriapoda
elongata	*Orthomorpha coarctata* (Sauss.)	Myriapoda
fontariae	*Polydesmus* sp.	Myriapoda
	Fontaria sp.	Myriapoda
impressa	*Parajulus impressus* (Say)	Myriapoda
juli	*Julus sabulosus* (L.)	Myriapoda
	Julus fallax Mein.	Myriapoda
julipusilli	*Julus* and *Parajulus*	Myriapoda
lactaria	*Callipus lactarius* (Say)	Myriapoda
larvata	*Spirobolus spinigerus* Wood	Myriapoda
nematoides	*Strongylosoma italicum* Latz.	Myriapoda
polydesmi	*Fontaria virginiensis* (Drury)	Myriapoda
polyxeni	*Polyxenus lagurus* (L).	Myriapoda
producta	*Julus varius* Fabricius	Myriapoda
robusta	*Parajulus venustus* Wood	Myriapoda
	Orthomorpha gracilis (C. Koch)	Myriapoda
	Orthomorpha sp.	Myriapoda
silene	*Lysiopetalum foetidissimum* Sav.	Myriapoda
spiroboli	*Spirobolus* sp.	Myriapoda
varians	*Schizophyllum corsicum* Bröl.	

GENERA OF UNCERTAIN POSITION

Ulivina elliptica	*Audouinia* sp.	Annelida
Ganymedes anaspidis	*Anaspides* sp.	Crustacea
Nematoides fusiformis	*Balanus* sp.	Crustacea
Agrippina bona	*Ceratophyllus fasciatus* Bosk.	Arachnida

HOSTS WITH THEIR CEPHALINE GREGARINE PARASITES

Host	Group	Parasite
Acilius sulcatus L.	Coleoptera	*Bothriopsis histrio*
Acis sp.	Coleoptera	*Sphaerorhynchus ophioides*
Aeschna constricta Say	Neuroptera	*Geniorhynchus aeschna*
sp.	Neuroptera	*Actinocephalus brachydactylus*
Agrion sp.	Neuroptera	*Menospora polyancatha*
sp.	Neuroptera	*Actinocephalus sieboldi*
sp.	Neuroptera	*Stylocephalus oligacanthus*
Allecula sp.	Coleoptera	*Gregarina tenuis*
Alobates pennsylvanica deGeer	Coleoptera	*Actinocephalus zophus*
Amara angustata Say	Coleoptera	*Steinina rotunda*
Anaspides sp.	Crustacea	*Ganymedes anaspidis*
Anthrenus verbasci Oliv.	Coleoptera	*Pyxinia möbuszi*
Aphodius nitidulus F.	Coleoptera	*Didymophyes leuckarti*
prodromus (Brahm.)	Coleoptera	*Didymophyes leuckarti*
Arrhenoplita bicornis Oliv.	Coleoptera	*Gregarina microcephala*
Asida grisea (F.)	Coleoptera	*Stylocephalus oblongatus*
opaca Say	Coleoptera	*Stylocephalus giganteus*
servillei Sol.	Coleoptera	*Hirmocystis asidae*
sp.	Coleoptera	*Stylocephalus giganteus*
Astacus sp.	Crustacea	*Gregarina millaria*
Attagenus pellio L.	Coleoptera	*Pyxinia frenzeli*
Atyaephyra desmaresti	Crustacea	*Uradiophora cuenoti*
Audouinia sp.	Annelida	*Ulivina elliptica*
Balanus improvisus	Crustacea	*Gregarina* sp. (Solger)
sp.	Crustacea	*Gregarina* sp. (Mawrodiadi)
sp.	Crustacea	*Gregarina* sp. (Kölliker)
sp.	Crustacea	*Uradiophora communis*
sp.	Crustacea	*Stylocephalus balani*
sp.	Crustacea	*Nematoides fusiformis*
Bibio sp.	Diptera	*Schneideria mucronata*
Blabera claraziana Sauss.	Orthoptera	*Pileocephalus blaberae*
Blaniulus hirsutus Bröl.	Myriapoda	*Stenophora brölemanni*
Blaps mortisaga L.	Coleoptera	*Stylocephalus longicollis* *Gregarina* sp. (Gaede)
Blattella germanica (L.)	Orthoptera	*Gregarina blattarum*
lapponica L.	Orthoptera	*Gamocystis tenax*
Boletophagus cornutus Panz.	Coleoptera	*Gregarina boletophagi*

HOST	GROUP	PARASITE
Brachyiulus superus Latz.	Myriapoda	*Stenophora brölemanni*
pusillus lusitanus Verh.	Myriapoda	*Stenophora brölemanni*
Brachystola magna Giard	Orthoptera	*Gregarina rigida*
Callipus lactarius (Say)	Myriapoda	*Amphoroides calverti*
		Stenophora lactaria
Cancer pagurus	Crustacea	*Frenzelina praemorsa*
Carabus auratus L.	Coleoptera	*Actinocephalus stelliformis*
		Ancyrophora gracilis
violaceus L.	Coleoptera	*Actinocephalus stelliformis*
		Ancyrophora gracilis
sp.	Coleoptera	*Ancyrophora gracilis*
Ceratophyllus fasciatus Bosk.	Arachnida	*Agrippina bona*
Cetonia aurata L.	Coleoptera	*Gregarina curvata*
Ceuthophilus latens Scud.	Orthoptera	*Gregarina longiducta*
maculatus (Say)	Orthoptera	*Gregarina longiducta*
stygius (Scud.)	Orthoptera	*Gregarina stygia*
valgus Scud.	Orthoptera	*Gregarina consobrina*
Chlaenius vestitus (Payk.)	Coleoptera	*Actinocephalus digitatus*
Chordeuma silvestre C. Koch	Myriapoda	*Stenophora chordeume*
Chrysomela haemoptera L.	Coleoptera	*Gregarina munieri*
violacea (Goeze)	Coleoptera	*Gregarina munieri*
Chtamalus stellatus	Crustacea	*Frenzelina chtamali*
Cistelides sp.	Neuroptera	*Acanthospora pileata*
Coccinella novemnotata Herbst	Coleoptera	*Gregarina katherina*
Coccinella sp.	Coleoptera	*Gregarina barbarara*
sp.	Coleoptera	*Gregarina fragilis*
Colymbetes fuscus L.	Coleoptera	*Bothriopsis histrio*
sp.	Coleoptera	*Legeria agilis*
sp.	Coleoptera	*Ancyrophora uncinata*
Coptotomus interrogatus (Fab.)	Coleoptera	*Gregarina globosa*
		Gregarina coptotomi
Craspedosoma legeri	Myriapoda	*Stenophora corsica*
rawlinsii Verh.	Myriapoda	*Stenophora aculeata*
Cratoparis lunatus Fab.	Coleoptera	*Asterophora craptoparis*
Crypticus sp.	Coleoptera	*Gregarina elongata*
Cryptops anomalons lusitanus Verh.	Myriapoda	*Nina gracilis*
hortensis Leach	Myriapoda	*Dactylophorus robustus*
Ctenophora sp.	Diptera	*Actinocephalus* sp.
Cyphon pallidulus Boh.	Coleoptera	*Sphaerocystis simplex*
Dendarus tristis Rossi	Coleoptera	*Gregarina cavalierina*
Dendrocoelum lacteum	Platyhelminthes	*Gregarina* sp. (Hallez)
Dermestes lardarius L.	Coleoptera	*Beloides firmus*
		Pyxinia rubecula
peruvianus Casteln.	Coleoptera	*Pyxinia crystalligera*

HOST	GROUP	PARASITE
undulatus Brahm.	Coleoptera	*Beloides tenuis*
vulpinus Fabr.	Coleoptera	*Pyxinia crystalligera*
		Pyxinia rubecula
Dicaelus ovalis Lec.	Coleoptera	*Actinocephalus dicaeli*
Dissosteira carolina L.	Orthoptera	*Gregarina locustae*
		Actinocephalus fimbriatus
Dorcus parallelopipedus L.	Coleoptera	*Actinocephalus conicus*
Dromia dromia	Crustacea	*Frenzelina dromiae*
Dytiscus sp.	Coleoptera	*Actinocephalus dytiscorum*
sp.	Coleoptera	*Bothriopsis histrio*
sp.	Coleoptera	*Ancyrophora uncinata*
Elater sp.	Coleoptera	*Gregarina elaterae*
sp.	Coleoptera	*Gregarina gracilis*
Eleodes sp.	Coleoptera	*Stylocephalus giganteus*
Embia sp.	Neuroptera	*Gregarina marteli*
Encoptolophus sordidus (Burm.)	Orthoptera	*Gregarina rigida*
		Gregarina nigra
Ephemera sp.	Neuroptera	*Gamocystis ephemerae*
sp.	Neuroptera	*Gregarina granulosa*
Eryx ater Fab.	Coleoptera	*Gregarina socialis*
Eupagurus prideauxi	Crustacea	*Frenzelina ocellata*
Euryurus erythropygus (Brandt)	Myriapoda	*Stenophora diplocorpa*
Eusattus sp.	Coleoptera	*Stylocephalus giganteus*
Fontaria sp.	Myriapoda	*Stenophora fontariae*
virginiensis (Drury)	Myriapoda	*Stenophora polydesmi*
Forficula auricularia L.	Orthoptera	*Gregarina ovata*
Galerita bicolor Drury	Coleoptera	*Actinocephalus americanus*
Gammarus pulex (L.)	Crustacea	*Didymophyes longissima*
		Gregarina sp. (Pfeiffer)
sp.	Crustacea	*Gregarina gammari*
sp.	Crustacea	*Gregarina millaria*
Geotrupes stercorarius (L.)	Coleoptera	*Didymophyes paradoxa*
Glomeris sp.	Myriapoda	*Cnemidospora lutea*
Glossiphonia sp.	Annelida	*Gregarina* sp. (Bolsius)
Gryllomorpha dalmatina Ocsk.	Orthoptera	*Gregarina davini*
Gryllotalpa gryllotalpa (L.)	Orthoptera	*Hirmocystis gryllotalpae*
sp.		*Gregarina sphaerulosa*
Gryllus abbreviatus Serv.	Orthoptera	*Gregarina achetaeabbreviatae*
		Gregarina galliveri
		Gregarina kingi
		Gregarina oviceps
		Leidyana erratica
campestris L.	Orthoptera	*Gregarina oblonga*
domesticus L.	Orthoptera	*Gregarina macrocephala*
		Leidyana gryllorum

Host	Group	Parasite
pennsylvanicus Burm.	Orthoptera	*Leidyana erratica*
Gyrinus natator (L.)	Coleoptera	*Corycella armata*
Harpalus caliginosus Fab.	Coleoptera	*Actinocephalus harpali*
		Gregarina parva
		Hirmocystis harpali
Harpalus pennsylvanicus Dej.	Coleoptera	*Actinocephalus gimbeli*
		Gregarina parva
pennsylvanicus longior (Kirby)	Coleoptera	*Steinina harpali*
Helenophorus collaris L.	Coleoptera	*Stylocephalus gladiator*
Helops striatus Geoff.	Coleoptera	*Lophocephalus insignis*
Herpobdella sp.	Annelida	*Gregarina* sp. (Bolsius)
Hesperotettix pratensis Scudd.	Orthoptera	*Gregarina rigida*
Himantarium gabrielis Linn.	Myriapoda	*Rhopalonia geophili*
		Rhopalonia stella
Hirudinea sp.	Annelida	*Metamera schubergi*
Hydaticus cinereus L.	Coleoptera	*Bothriopsis histrio*
Hydrobius sp.	Coleoptera	*Cometoides crinitus*
Hydrophilus piceus (L.)	Coleoptera	*Phialoides ornata*
sp.	Coleoptera	*Stylocephalus brevirostris*
sp.	Coleoptera	*Bothriopsis terpsichorella*
Hydrous caraboides (L.)	Coleoptera	*Acanthospora polymorpha*
sp.	Coleoptera	*Cometoides capitatus*
Ischnoptera pennsylvanica (deGeer)	Orthoptera	*Gregarina illinensis*
Julus boleti C. Koch.	Myriapoda	*Stenophora dauphinia*
		Stenophora juli
fallax Mein.	Myriapoda	*Stenophora dauphinia*
		Stenophora juli
mediterraneus Latz.	Myriapoda	*Stenophora dauphinia*
sabulosus (L.)	Myriapoda	*Stenophora juli*
varius Fab.	Myriapoda	*Stenophora producta*
sp.	Myriapoda	*Stenophora julipusilli*
Lepisma saccharina L.	Thysanura	*Gregarina lagenoides*
Leptochirus edax Sharp	Coleoptera	*Actinocephalus crassus*
		Stylocystis ensifera
Libellules sp.	Neuroptera	*Geniorhynchus monnieri*
Libinia dubia	Crustacea	*Frenzelina olivia*
Limnobia sp.	Diptera	*Hirmocystis polymorpha*
Limnophilus rhombicus	Neuroptera	*Ancyrophora uncinata*
Lithobius calcaratus Koch	Myriapoda	*Echinomera horrida*
coloradensis Cock.	Myriapoda	*Echinomera hispida*
forficatus Linn.	Myriapoda	*Actinocephalus dujardini*
		Acutispora macrocephala
		Echinomera hispida

Host	Group	Parasite
Lucanus dama Thunb.	Coleoptera	*Gregarina lucani*
Lysiopetalum foetidissimum Sav.	Myriapoda	*Stenophora silene*
lactarium (Say)	Myriapoda	*Amphoroides calverti*
Machilis cylindrica Geoff.	Thysanura	*Hyalospora affinis*
Melolontha brunnea Blanch.	Coleoptera	*Gregarina melolonthae*
sp.	Coleoptera	*Stictospora provincialis*
Melanoplus angustipennis (Dodge)	Orthoptera	*Gregarina rigida*
atlantis (Riley)		*Gregarina rigida*
bivittatus (Say)		*Gregarina rigida*
coloradensis (Say)		*Gregarina rigida*
differentialis (Uhler)		*Gregarina rigida*
femoratus (Burm.)		*Gregarina rigida*
femur-rubrum (deGeer)		*Gregarina rigida*
luridus (Dodge)		*Gregarina nigra*
Morica sp.	Coleoptera	*Oocephalus hispanus*
Mystacida sp.	Neuroptera	*Gregarina mystacidorum*
Mystacides sp.	Neuroptera	*Pileocephalus chinensis*
Necrobia ruficollis Fabr.	Coleoptera	*Pileocephalus bergi*
Nemobius sylvestris (F.)	Orthoptera	*Gregarina macrocephala*
Nepa sp.	Hemiptera	*Coleorhynchus heros*
Ninus interstitialis Esch.	Coleoptera	*Gregarina guatemalensis*
Nyctobates barbata Knoch	Coleoptera	*Actinocephalus zophus*
pennsylvanica (deGeer)	Coleoptera	*Actinocephalus zophus* *Asterophora philica* *Gregarina* sp. (Crawley)
Ocypus olens (Mull.)	Coleoptera	*Actinocephalus stelliformis*
Oedipoda migratoria L.	Orthoptera	*Gregarina oblonga*
stridula L.	Orthoptera	*Gregarina oblonga*
Omoplus sp.	Coleoptera	*Acanthospora pileata*
Opatrum sabulosum (L.)	Coleoptera	*Stylocephalus oblongatus*
Orchesella villosa	Thysanura	*Gregarina podurae*
Orchestia littorea Leach	Crustacea	*Didymophyes longissima*
Orthomorpha coarctata (Sauss.)	Myriapoda	*Stenophora elongata*
gracilis (C. Koch)	Myriapoda	*Stenophora robusta*
sp.	Myriapoda	*Stenophora robusta*
Oryctes nasicornis (L.)	Coleoptera	*Didymophyes gigantea*
sp.	Coleoptera	*Didymophyes gigantea*
Pachygraspus marmoratus	Crustacea	*Frenzelina conformis*
Pachyrhina sp.	Diptera	*Hirmocystis ventricosa*
Pamphagus sp.	Orthoptera	*Gregarina acridiorum*
Panchlora exoleta (Klug)	Orthoptera	*Gregarina panchlorae*

Host	Group	Parasite
Parajulus impressus (Say)	Myriapoda	*Stenophora impressa*
venustus Wood	Myriapoda	*Stenophora robusta*
sp.	Myriapoda	*Stenophora cockerellae*
sp.	Myriapoda	*Stenophora julipusilli*
Parnus sp.	Coleoptera	*Gregarina laucournetensis*
Passalus cornutus Fab.	Coleoptera	*Gregarina passali*
Periplaneta americana (L.)	Orthoptera	*Gregarina blattarum*
orientalis (L.)	Orthoptera	*Gregarina blattarum*
		Gregarina serpentula
Peripatus sp.	Onycophora	*Gregarina* sp. (Moseley)
Perophora annectens	Tunicata	*Gregarina* sp. (Ritter)
Petrobius maritimus Leach	Thysanura	*Hyalospora roscoviana*
Phalangida sp.	Arachnida	*Anthorhynchus sophiae*
Phalangides sp.	Arachnida	*Anthorhynchus fissidens*
sp.	Arachnida	*Stylocephalus caudatus*
Phalangium sp.	Arachnida	*Anthorhynchus gonorowitschi*
sp.	Arachnida	*Sciadophora phalangii*
sp.	Arachnida	*Actinocephalus repelini*
Phallusia sp.	Mollusca	*Stylocephalus phallusiae*
Phronima sp.	Crustacea	*Gregarina clausi*
Phryganea sp.	Neuroptera	*Actinocephalus octacanthus*
sp.	Neuroptera	*Asterophora elegans*
sp.	Neuroptera	*Stylocephalus heeri*
Phyllognathus sp.	Coleoptera	*Didymophyes gigantea*
Pimelia sp.	Coleoptera	*Cystocephalus algerianus*
Pinotheres pisum	Crustacea	*Frenzelina fossor*
Platycarcinus sp.	Crustacea	*Gregarina praemorsa*
Platynus ruficollis Marsh.	Coleoptera	*Gregarina platyni*
Poecilus cupreus (L.)	Coleoptera	*Gregarina amarae*
Pollicipes sp.	Crustacea	*Gregarina valettei*
Polydesmus complanatus (L.)	Myriapoda	*Amphoroides polydesmi*
dispar Silvestri	Myriapoda	*Amphoroides polydesmi*
sp.	Myriapoda	*Stenophora fontariae*
Polyxenus lagurus (L.)	Myriapoda	*Stenophora polyxeni*
Portunus arcuatus	Crustacea	*Frenzelina portunidarum*
Psocus sp.	Neuroptera	*Gregarina psocorum*
Pterostichus stygicus (Say)	Coleoptera	*Gregarina intestinalis*
		Gregarina monarchia
Pterotrachea sp.	Mollusca	*Gregarina pterotracheae*
Reduvius personatus L.	Hemiptera	*Hyalospora reduvii*
Rhizotrogus aestivus Oliv.	Coleoptera	*Euspora fallax*
sp.	Coleoptera	*Actinocephalus stelliformis*
		Stictospora provincialis
Rhyacophila sp.	Neuroptera	*Asterophora mucronata*
Rhynchobolus americanus	Annelida	*Gregarina* sp. (Porter)

Host	Group	Parasite
Salpa aernginosa	Tunicata	*Gregarina ensiformis*
confoederata	Tunicata	*Gregarina flava*
maxima	Tunicata	*Gregarina salpae*
vagina	Tunicata	*Gregarina flava*
Scarabaeus relictus	Coleoptera	*Gregarina scarabaei*
Schistocerca americana Burm.	Orthoptera	*Gregarina rigida*
paranensis Burm.	Orthoptera	*Gregarina paranensis*
Schizophyllum corsicum Bröl.	Myriapoda	*Stenophora varians*
Sciara sp.	Diptera	*Actinocephalus caudatus*
Scolopendra cingulata (Latr.)	Myriapoda	*Nina gracilis* *Actinocephalus striatus*
heros Giard	Myriapoda	*Amphorocephalus amphorellus*
oraniensis	Myriapoda	*Nina giardi*
oraniensis lusitanica Verh.	Myriapoda	*Nina giardi corsicum*
subspinipes Leach	Myriapoda	*Nina indicia*
woodi Mein.	Myriapoda	*Hoplorhynchus scolopendras*
Scolopocryptops sexspinosus (Say)	Myriapoda	*Hoplorhynchus actinotus*
sp.	Myriapoda	*Hoplorhynchus actinotus*
Scutigera forceps (Raf.)	Myriapoda	*Trichorhynchus pulcher*
sp.	Myriapoda	*Trichorhynchus pulcher*
Sericostoma sp.	Neuroptera	*Taeniocystis truncata*
sp.	Coleoptera	*Ancyrophora uncinata*
Silpha laevigata F.	Coleoptera	*Actinocephalus acutispora*
thoracica L.		*Ancyrophora gracilis*
Sphingonotus sp.	Orthoptera	*Gregarina acridiorum*
Spirobolus sp.	Myriapoda	*Stenophora spiroboli*
spinigerus Wood	Myriapoda	*Stenophora larvata*
Statira unicolor Blanch.	Coleoptera	*Gregarina statirae*
Stigmatogaster gracilis Mein.	Myriapoda	*Rhopalonia geophili*
Strongylosomum italicum Latz.	Myriapoda	*Stenophora nematoides*
Talorchestia longicornis	Crustacea	*Frenzelina delphinia*
Tanypes sp.	Diptera	*Stylocystis praecox*
Tenebrio castaneus Knoch	Coleoptera	*Gregarina grisea*
molitor L.	Coleoptera	*Gregarina cuneata* *Gregarina polymorpha* *Gregarina steini* *Steinina ovalis*
Tenebrionidae	Coleoptera	*Gregarina tenebrionella*
Termes sp.	Neuroptera	*Gregarina termitis*
Thanasimus formicarius (L.)	Coleoptera	*Gregarina longirostris*
Timarcha tenebricosa (F.)	Coleoptera	*Gregarina munieri*
Tipula sp.	Diptera	*Gregarina longa*
sp.	Diptera	*Gregarina tipula*
sp.	Diptera	*Hirmocystis ventricosa*
sp.	Diptera	*Actinocephalus tipulae*

Host	Group	Parasite
Tribolium ferrugineum F	Coleoptera	*Gregarina minuta*
		Steinina obconica
		Didymophyes minuta
Tridactylus variegatus Latr.	Orthoptera	*Gregarina hyalocephala*
Trox perlatus Scriba	Coleoptera	*Gregarina acuta*
Tryxalis sp.	Orthoptera	*Gregarina acridiorum*
Uca pugilator	Crustacea	*Frenzelina nigrofusca*
pugnax	Crustacea	*Frenzelina nigrofusca*
Udeopsylla nigra	Locustidae	*Gregarina udeopsyllae*
Xylopinus saperdioides Oliv.	Coleoptera	*Stylocephalus* sp.

LIST OF NEW SPECIES

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†Described in The Journal of Parasitology, 2:129-136.

*A preliminary description was given in The Journal of Parasitology, 2:27-36.

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EXPLANATIONS OF PLATES

All original drawings were made with the camera lucida directly from the live material and the magnification of each is given.

All the drawings which were copied from other authors were drawn by means of the camera lucida and the source of each drawing is given in the explanation of the individual plates. No magnifications are mentioned in the majority of the original sources and hence none can be given here.

EXPLANATION OF PLATE

Fig. 1. *Stenophora larvata* (Leidy) Ellis. After Leidy, 1853, Plate X, Fig. 1.

Figs. 2, 3, 4. *Stenophora polydesmi* (Lankester) Watson. After Leidy, 1853, Plate XI, Figs. 23, 25, 27.

Fig. 5. *Stenophora julipusilli* (Labbé) Crawley. After Leidy, 1853, Plate X, Fig. 21.

Fig. 6. *Stenophora julipusilli* (Labbé) Crawley. After Crawley, 1903a, Plate XXX, Fig. 17.

Fig. 7. *Stenophora juli* (Frantzius) Labbé. After Frantzius, 1848, Plate VII, x, Fig. 1.

Fig. 8. *Stenophora juli* (Frantzius) Labbé. After Schneider, 1875, Plate XX, Fig. 29.

Fig. 9. *Stenophora dauphinia* Watson. After Léger and Duboscq, 1904, Plate XIV, Fig. 13.

Fig. 10. *Stenophora spiroboli* Crawley. After Crawley, 1903, Plate II, Fig. 22.

Figs. 11, 12. *Stenophora fontariae* (Crawley) Watson. After Crawley, 1903, Plate I, Fig. 12; Fig. 14.

Fig. 13. *Stenophora brölemanni* Léger and Duboscq. After Léger and Duboscq, 1903a, Fig. 21.

Figs. 14, 15. *Stenophora nematoides* Léger and Duboscq. After Léger and Duboscq, 1903a, Fig. 17(2), Fig. 17(1).

Figs. 16, 17. *Stenophora varians* Léger and Dubosq. After Léger and Duboscq, 1903a, elongate form Fig. 18; globose form Fig. 20.

Fig. 18. *Stenophora producta* Léger and Duboscq. After Léger and Duboscq, 1904, Plate 14, Fig. 10.

Figs. 19, 20. *Stenophora aculeata* Leger and Duboscq. After Léger and Duboscq, 1904, Plate 14, Fig. 5; protomerite Fig. 14.

Fig. 21. *Stenophora polyxeni* Léger and Duboscq. After Léger and Duboscq, 1904, Plate 14, Fig. 6.

Figs. 22, 23. *Stenophora silene* Léger and Duboscq. After Léger and Duboscq, 1904, Plate 14, elongate form Fig. 12b; globose form Fig. 12a.

Figs. 24, 25. *Stenophora chordeume* Léger and Duboscq. After Léger and Duboscq, 1904, Plate 14, globose form Fig. 11; elongate form Fig. 15.

Fig. 26. *Stenophora robusta* Ellis. After Ellis, 1912b, Fig. 1b.

Fig. 27. *Stenophora cockerellae* Ellis. After Ellis, 1912a, Fig. 1c.

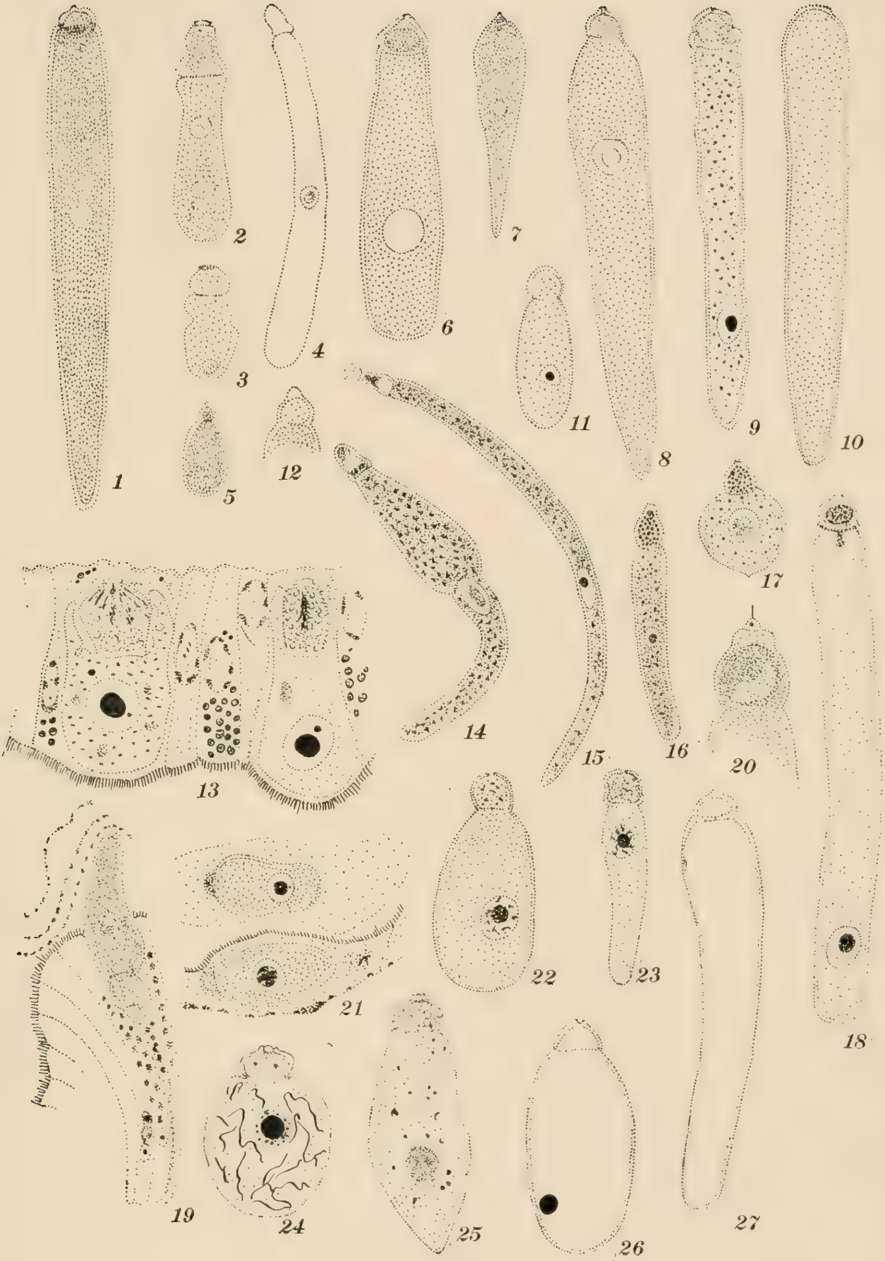
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PLATE I

PLATE II

EXPLANATION OF PLATE

Fig. 28. *Stenophora elongata* Ellis. After Ellis, 1912a, Fig. 4n.

Fig. 29. *Dactylophorus robustus* Léger. After Labbé, 1899, Fig. 27.

Fig. 30. *Nina gracilis* Grebnecki. After Labbé, 1899, Fig. 24.

Fig. 31. *Nina giardi corsicum* (Léger and Duboscq) Sokolow. After Léger and Duboscq, 1903a, Fig. 15.

Fig. 32. *Echinomera hispida* (Schneider) Labbé. After Schneider, 1875, Plate XVI, Fig. 36.

Fig. 33. *Nina indicia* Merton. After Merton, 1911, Plate III, Fig. 1.

Fig. 34. *Acutispora macrocephala* Crawley. After Crawley, 1903a, Plate XXX, Fig. 1.

Fig. 35. *Trichorhynchus pulcher* Schneider. After Leidy, 1889, Fig. 3.

Fig. 36. *Trichorhynchus pulcher* Schneider. After Schneider, 1882, Plate XIII, Fig. 14.

Fig. 37. *Actinocephalus striatus* Léger and Duboscq. After Léger and Duboscq, 1903a, Fig. 16.

Figs. 38, 39, 40. *Actinocephalus dujardini* Schneider. After Schneider, 1875, Plate XVI, Fig. 9; Fig. 10; Fig. 12.

Fig. 41. *Hoplorhynchus scolopendras* Crawley. After Crawley, 1903a, Plate XXX, Fig. 19.

Figs. 42, 43. *Hoplorhynchus actinotus* (Leidy) Crawley. After Crawley, 1903, Plate III, Fig. 37; Leidy, 1889, Fig. 2.

Fig. 44. *Trichorhynchus lithobii* Crawley. After Crawley, 1903a, Plate XXX, Fig. 18.

Figs. 45, 46. *Amphorocephalus amphorellus* Ellis. After Ellis, 1913, Fig. 1; Fig. 2.

Fig. 47. Species of uncertain genus. After Balbiani, 1889, Plate II, Fig. 34.

Fig. 48. Species of uncertain genus. After Kölliker, 1848, Plate III, Fig. 30.

Figs. 49, 50. *Nina gracilis* Grebnecki, in section. After Léger and Duboscq, 1902, Plate VI, Fig. 93; Fig. 96.

Fig. 51. *Rhopalonia geophili* Léger. After Labbé, 1899, Fig. 21.

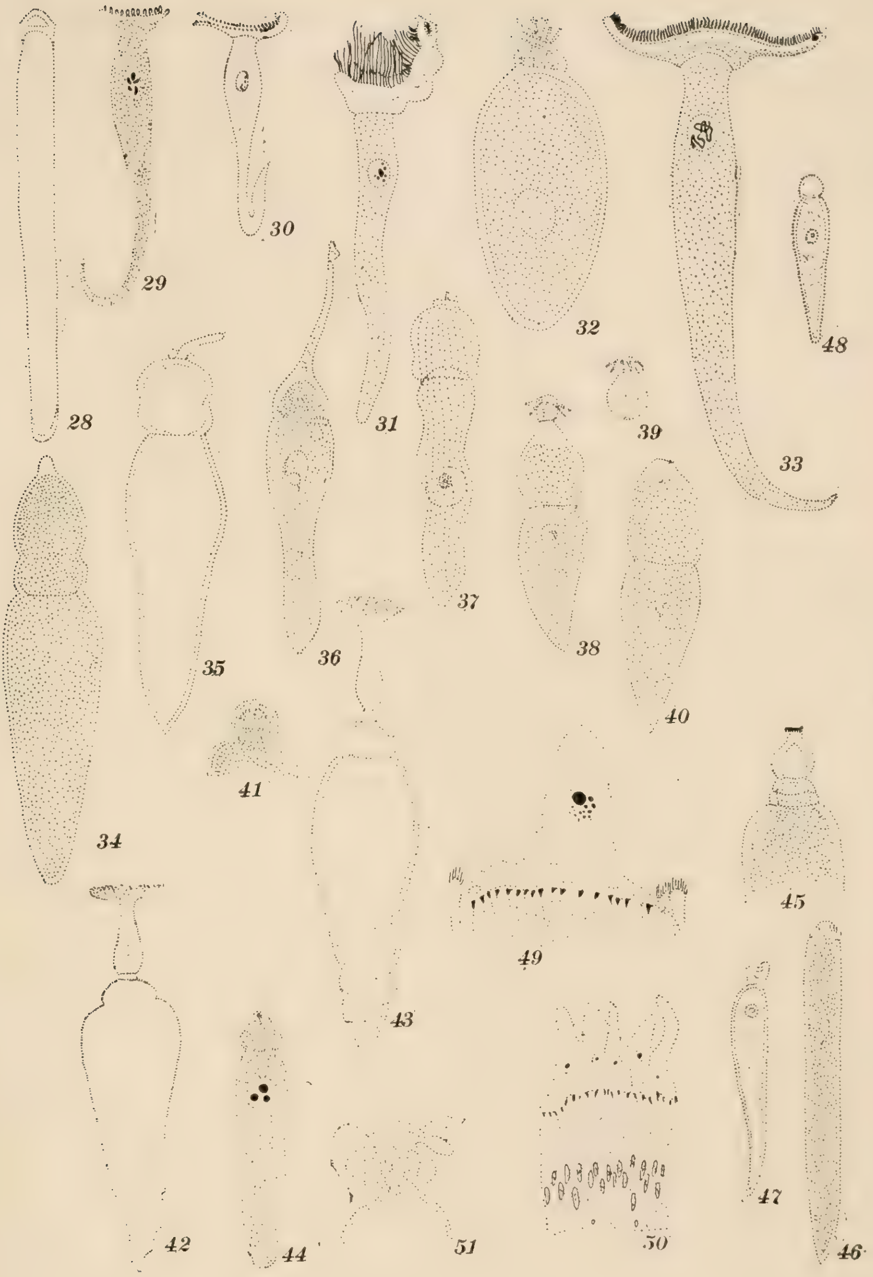
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PLATE II

PLATE III

EXPLANATION OF PLATE

Fig. 52. *Amporoides calverti* (Crawley) Watson., × 195.
Fig. 53. *Stenophora impressa* Watson, × 195.
Fig. 54. *Stenophora diplocorpa* Watson, × 195.
Fig. 55. *Stenophora lactaria* Watson, × 195.
Figs. 56, 57. *Cnemidospora lutea* Schneider. After Schneider, 1882, Plate XIII, Fig. 44; protomerite, Fig. 44.
Fig. 58. *Amphoroides polydesmi* (Léger) Labbé. After Léger, 1892, Plate X, Fig. 10.
Figs. 59, 60. *Didymophyes leuckarti* Marshall. After Marshall, 1893, Plate II, Fig. 24; Fig. 26.
Fig. 61. *Didymophyes gigantea* Stein. After Stein, 1848, Plate XI, Fig. 40.
Fig. 62. *Didymophyes paradoxa* Stein. After Léger, 1892, Plate VI, Fig. 14.
Fig. 63. *Didymophyes gigantea* Stein. After Labbé, 1889, Fig. 4.
Fig. 64. *Actinocephalus americanus* Crawley. After Crawley, 1903a, Plate XXX, Fig. 22.
Fig. 65. *Stylocephalus* sp. After Crawley, 1903, Plate III, Fig. 29.
Fig. 66. *Actinocephalus digitatus* Schneider. After Schneider, 1875, Plate XVI, Fig. 35.
Fig. 67. *Actinocephalus stelliformis* Schneider. After Schneider, 1875, Plate XVI, Fig. 32.
Fig. 68. *Actinocephalus crassus* (Ellis). After Ellis, 1912a, Fig. 7.
Fig. 69. *Actinocephalus stelliformis* Schneider. After Schneider, 1875, Plate XVI, Fig. 32.
Fig. 70. *Actinocephalus harpali* Crawley. After Crawley, 1903, Plate I, Fig. 1.
Fig. 71. *Didymophyes minuta* (Ishii) Watson. After Ishii, 1914, Fig. 2a.
Fig. 72. *Didymophyes paradoxa* Stein. After Stein, Plate IX, Fig. 34.
Fig. 73. *Actinocephalus stelliformis* Schneider. After Schneider, 1875, Plate XX, Fig. 20.
Fig. 74. *Actinocephalus zophus* (Ellis). After Ellis, 1913a, Fig. 2.

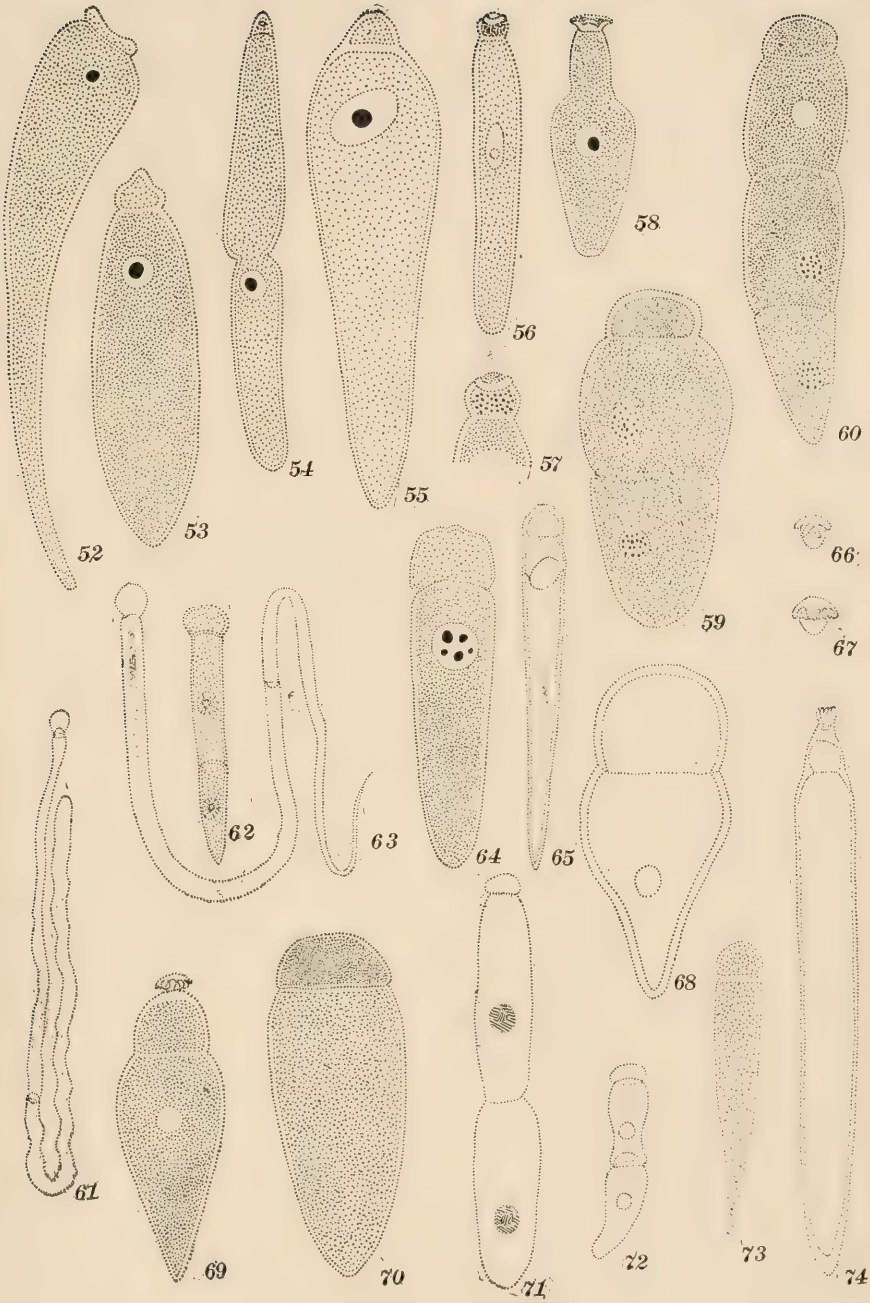
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PLATE III

PLATE IV

EXPLANATION OF PLATE

Figs. 75, 76. *Actinocephalus conicus* (Dufour) Frantzius. After Stein, 1848, Plate IX, Fig. 33; Léger, 1892, Plate XII, Fig. 3.

Fig. 77. *Asterophora cratoparis* Crawley. After Crawley, 1903, Plate II, Fig. 23.

Fig. 78. *Asterophora philica* (Leidy) Crawley. After Crawley, 1903, Plate III, Fig. 31.

Fig. 79. *Bothriopsis histrio* Schneider. After Schneider, 1875, Plate XXI, Fig. 13.

Fig. 80. *Bothriopsis terpsichorella* (Ellis) Watson. After Ellis, 1913b, Plate XVIII, Fig. 30.

Fig. 81. *Bothriopsis histrio* Schneider. After Léger, 1892, Plate XIII, Fig. 1.

Fig. 82. *Legeria agilis* (Schneider) Labbé. After Schneider, 1875, Plate XXII, Fig. 1.

Fig. 83. *Pileocephalus bergi* (Frenzel) Labbé. After Frenzel, 1892, Plate VIII, Fig. 16.

Figs. 84, 85, 86. *Pyxinia crystalligera* Frenzel. After Frenzel, 1892, Plate VIII, Fig. 40; Fig. 36; Fig. 37.

Figs. 87, 88. *Phialoides ornata* (Léger) Labbé. After Léger, 1892, Plate XIII, Fig. 8; Fig. 7.

Fig. 89. *Pyxinia frenzeli* Laveran and Mesnil. After Laveran and Mesnil, 1900, Fig. 5.

Figs. 90, 91. *Stictospora provincialis* Léger. After Labbé, 1899, Fig. 43; Fig. 42.

Figs. 92, 93, 94. *Steinina ovalis (Stein)* Léger and Duboscq. After Léger and Duboscq, 1904, Fig. 3c; Fig. 4a; Fig. 4d.

Fig. 95. *Steinina obconica* Ishii. After Ishii, 1914, Fig. 4.

Fig. 96. *Stylocystis ensifera* (Ellis). After Ellis, 1912a, Fig. 5.

Figs. 97, 98. *Pyxinia möbuszi* Léger and Duboscq. After Léger and Duboscq, 1902, Plate VI, Fig. 60; Fig. 58.

Fig. 99. *Stylocystis ensifera* (Ellis). After Ellis, 1912a, Fig. 5s.

Fig. 100. *Actinocephalus dicaeli* (Crawley) Ellis. After Crawley, 1903, Plate I, Fig. 7.

Fig. 101. *Actinocephalus conicus* (Dufour) Frantzius. After Dufour, 1837, Plate I, Fig. 7.

Fig. 102. *Actinocephalus conicus* (Dufour) Frantzius. After Dufour, 1837, Plate I, Fig. 7a.

Fig. 103. *Actinocephalus conicus* (Dufour) Frantzius. After Léger, 1892, Plate XII, Fig. 4.

Fig. 104-5. Indeterminate species, called by Crawley *Asterophora philica.* After Crawley, 1903, Plate III, Fig. 32; Fig. 33.

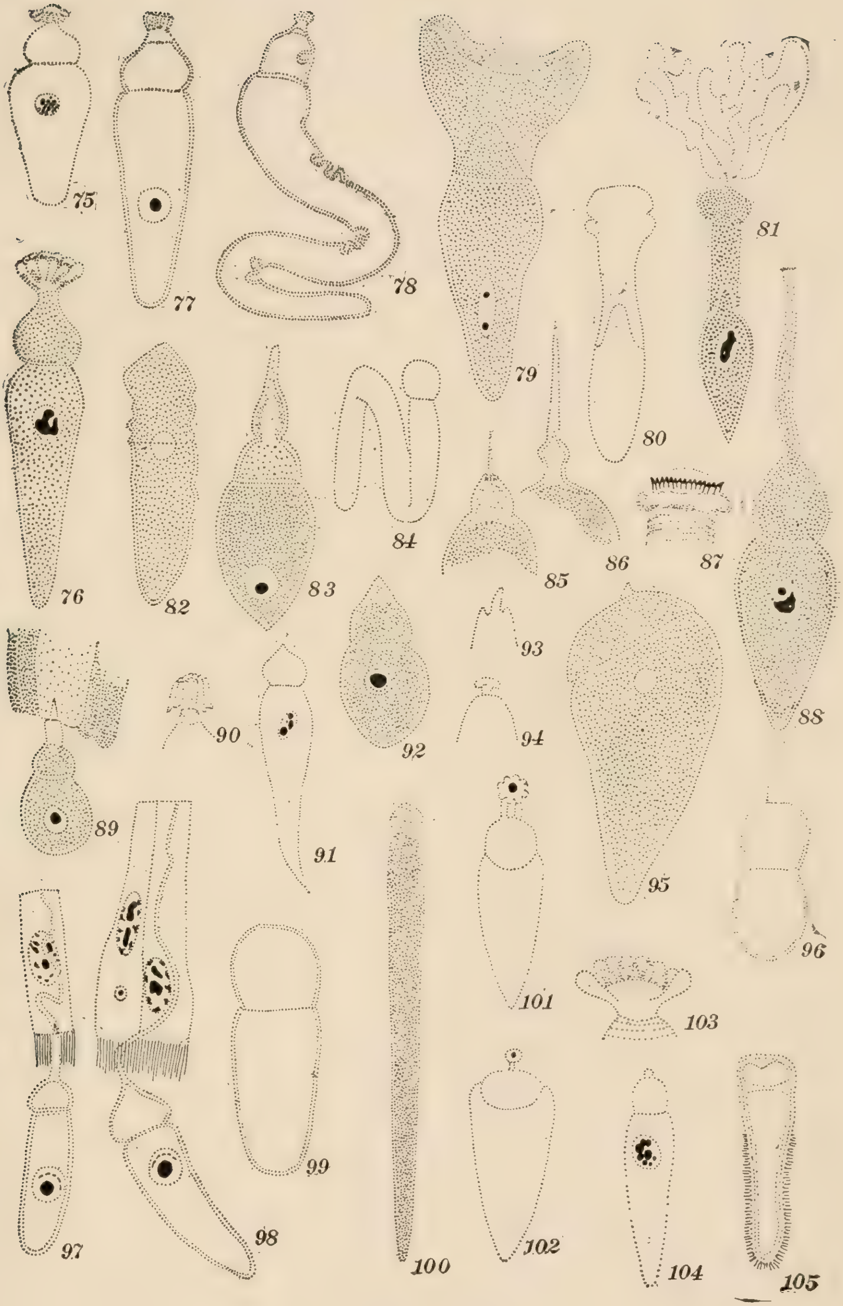
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PLATE IV

PLATE V

EXPLANATION OF PLATE

Fig. 106. *Stylocephalus oblongatus* (Hammerschmidt) Watson. After Schneider, 1875, Plate XVIII, Fig. 3.

Fig. 107. *Stylocephalus longicollis* (Stein) Watson. After Schneider, 1875, Plate XIX, Fig. 1.

Figs. 108, 109. *Stylocephalus giganteus* Ellis. After Ellis, 1912, Fig. 2; Fig. 1d.

Fig. 110. *Lophocephalus insignis* (Schneider) Labbé. After Schneider, 1882, Plate XIII, Fig. 1.

Figs. 111, 112. *Corycella armata* Léger. After Léger, 1892, Plate XVI, Fig. 7; Fig. 8.

Fig. 113. *Asterophora philica* (Leidy) Crawley. After Leidy, 1889, Fig. 7.

Fig. 114. *Lophocephalus insignis* (Schneider) Labbé. After Wasielewski, 1896, Fig. 5.

Fig. 115. *Cystocephalus algerianus* Schneider, cephalont. After Labbé, 1899, Fig. 82.

Fig. 116. *Beloides firmus* (Léger) Labbé. After Labbé, 1899, Fig. 64.

Fig. 117. *Beloides tenuis* (Léger) Labbé. After Labbé, 1899, Fig. 65.

Fig. 118. *Stylocephalus brevirostris* (Kölliker) Watson. After Kölliker, 1848, Plate II, Fig. 14.

Fig. 119. *Pyxinia rubecula* Hammerschmidt. After Frantzius, 1848, Plate VII, Group II, Fig. 1.

Fig 120. *Stylocephalus oblongatus* (Hammerschmidt) Watson. After Schneider, 1875, Plate XVIII, Fig. 5.

Fig. 121. *Stylocephalus longicollis* (Stein) Watson. After Schneider, 1875, Plate XIX, Fig. 2.

Fig. 122. *Ancyrophora gracilis* Léger. After Léger, 1892, Plate XIX, Fig. 11.

Figs. 123, 124. *Cometoides capitatus* (Léger) Labbé. After Léger, 1892, Plate XVI, Fig. 3; Fig. 4.

Fig. 125. *Cometoides crinitus* (Léger) Labbé. After Léger, 1892, Plate XVIII, Fig. 3.

Figs. 126, 127. *Actinocephalus gimbeli* (Ellis) Watson. After Ellis, 1913, Fig. 4, Fig. 3.

Fig. 128. Epimerite of *Gregarina munieri* (Schneider) Labbé. After Schneider, 1875, Plate XVII, Fig. 2.

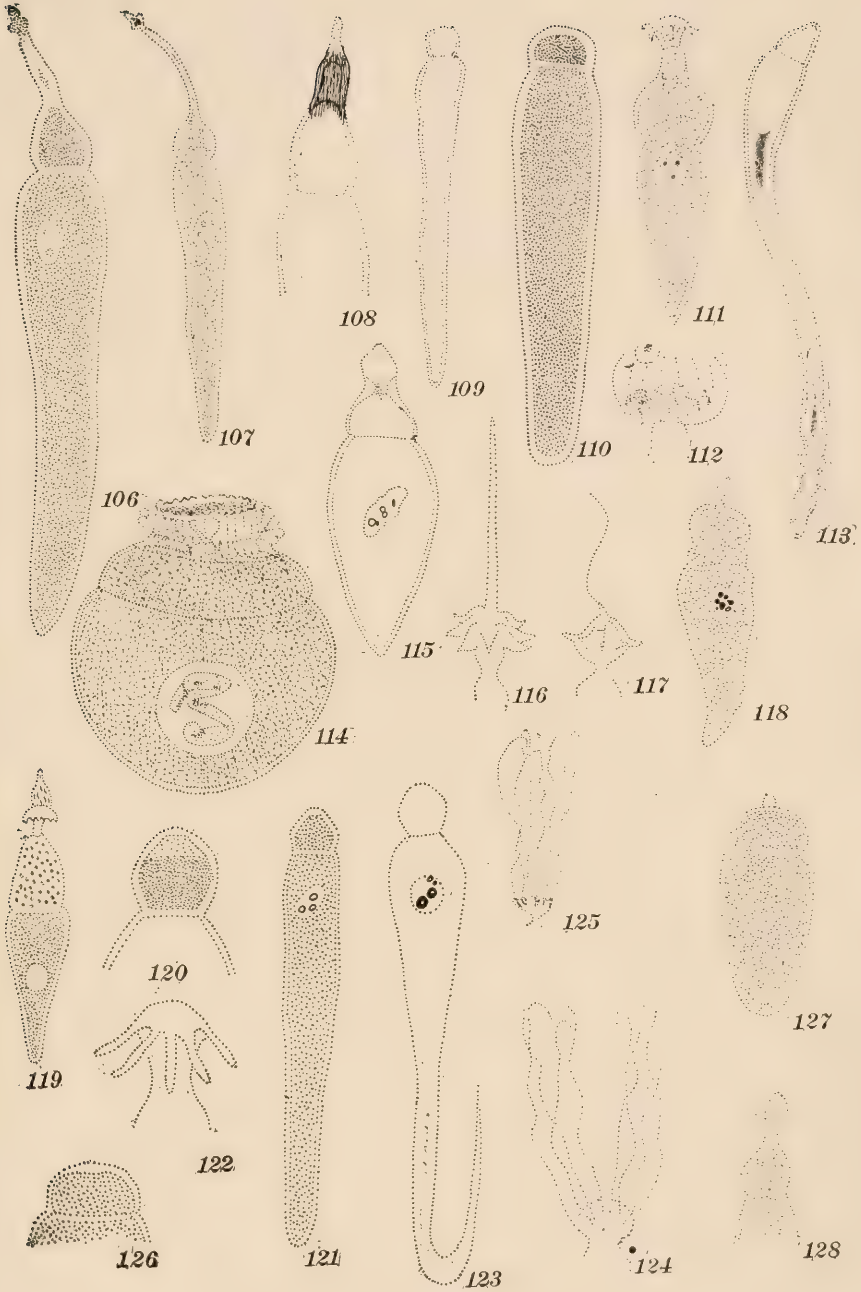
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PLATE V

PLATE VI

EXPLANATION OF PLATE

Fig. 129. *Hyalospora roscoviana* Schneider. After Schneider, 1875, Plate XVI, Fig. 41.

Fig. 130. *Gregarina parva* (Crawley) Watson. After Crawley, 1903a, Plate XXX, Fig. 10.

Fig. 131. *Euspora fallax* Schneider. After Schneider, 1875, Plate XVIII, Fig. 14.

Figs. 132, 133, 134, 135, 136. *Gregarina cuneata* Stein. After Schneider, 1875, Plate XX, Fig. 11; Stein, 1848, Plate IX, Fig. 23; Crawley, 1903, Plate III, Fig. 30; Frantzius, 1848, Plate VII, Group V, Fig. 1; Ishii, 1914, Fig. 1.

Fig. 137. *Sphaerocystis simplex* Léger. After Léger, 1892, Plate VI, Fig. 11.

Fig. 138. *Gregarina statirae* Frenzel. After Frenzel, 1892,Plate VIII, Fig. 1.

Fig. 139. *Gregarina passali* Lankester. After Crawley, 1903, Plate II, Fig. 24.

Figs. 140, 141, 142. *Gregarina polymorpha* (Hammerschmidt) Stein. After Frantzius, 1848, Plate VII, Group V, Fig. 2; Schneider, 1875, Plate XX, Fig. 10; Stein, 1848, Plate IX, Fig. 24.

Fig. 143. *Gregarina minuta* Ishii. After Ishii, 1914, Fig. 2b.

Fig. 144. *Gregarina guatemalensis* Ellis. After Ellis, 1912a, Fig. 6t.

Fig. 145. Uncertain species (*Gregarina boletophagi* Crawley). After Crawley, 1903, Plate II, Fig. 26.

Fig. 146. *Gregarina steini* Berndt. After Berndt, 1902, Plate XIII, Fig. 69.

Fig. 147. *Gregarina munieri* (Schneider) Labbé. After Schneider, 1875, Plate XVII, Fig. 1.

Fig. 148. *Actinocephalus dytiscorum* (Frantzius) Watson. After Frantzius, 1848, Plate VII, Group VII, Fig. 1.

Fig. 149. Uncertain species (*Gregarina microcephala* Leidy). After Leidy, 1889, Fig. 4.

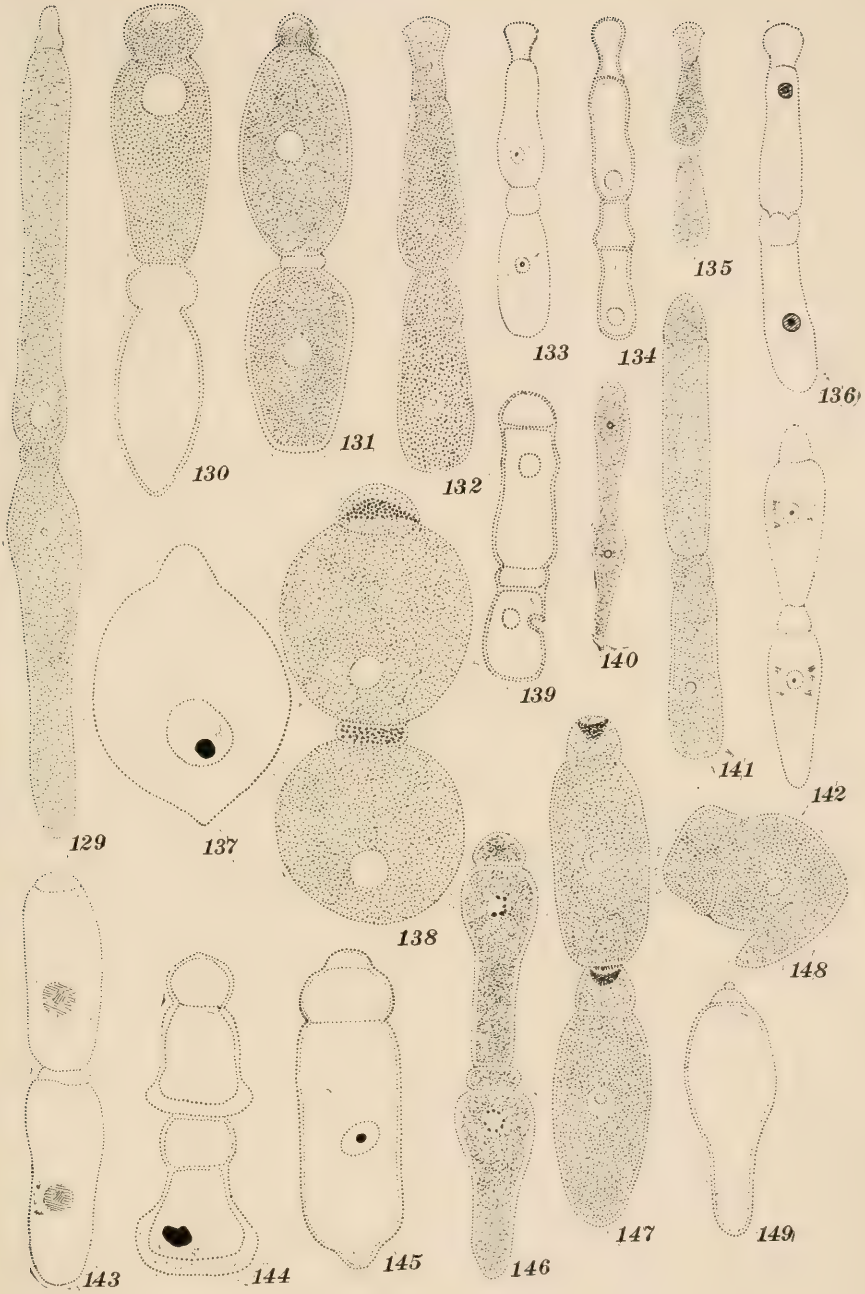
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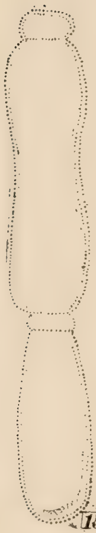
PLATE VI

PLATE VII

EXPLANATION OF PLATE

Fig. 150. *Gregarina lucani* (Crawley) Watson. After Crawley, 1903, Plate III, Fig. 38.
Fig. 151. *Gregarina grisea* Ellis. After Ellis, 1913a, Fig. 1.
Fig. 152. *Gregarina cuneata* Stein. After Léger and Duboscq, 1904, Fig. 5.
Fig. 153. *Gregarina polymorpha* (Hammerschmidt) Stein. After Léger and Duboscq, 1904, Fig. 6.
Fig. 154. *Gregarina elongata* Frantzius. After Frantzius, 1848, Plate VII, Group IV, Fig. 2.
Fig. 155. *Gregarina longirostris* (Léger) Labbé. After Léger, 1892, Plate XI, Fig. 5.
Figs. 156, 157. Uncertain species *(Gregarina ovalis* (Crawley) Watson). After Crawley, 1903, Plate I, Fig. 5; Fig. 6.
Fig. 158. Uncertain species (*Gregarina elaterae* Crawley). After Crawley, 1903, Plate I, Fig. 11.
Fig. 159. *Pyxinia rubecula* Hammerschmidt. After Léger, 1892, Plate XIV, Fig. 2.
Fig. 160. Spore of *Cystocephalus algerianus* Schneider. After Labbé, 1899, Fig. 8.
Fig. 161. Spores of *Lophocephalus insignis* (Schneider) Labbé. After Schneider, 1882, Plate XIII, Figs. 48, 50.
Fig. 162. Spore of *Acanthospora pileata* Léger. After Léger, 1892, Plate XV, Fig. 5a.
Fig. 163. Spore of *Acanthospora polymorpha* Léger. After Labbé, 1899, Fig. 68.
Fig. 164. Spore of *Ancyrophora gracilis* Léger. After Léger, 1892, Plate XIX, Fig. 12b.
Fig. 165. Spore of *Cometoides capitatus* (Léger) Labbé. After Léger, 1892, Plate XVI, Fig. 5.
Fig. 166. Spore of *Corycella armata* Léger. After Léger, 1892, Plate XVI, Fig. 10.
Fig. 167. *Gregarina monarchia* Watson, × 60.
Fig. 168. *Gregarina intestinalis* Watson, × 190.
Fig. 169. *Gregarina barbarara* Watson, × 245.
Fig. 170. *Gregarina gracilis* Watson, × 195.
Fig. 171. *Gregarina katherina* Watson, × 245.
Fig. 172. *Gregarina coptotomi* Watson, × 195.
Fig. 173. *Steinina rotunda* Watson, × 195.
Fig. 174. *Gregarina tenebrionella* Watson, × 195.
Fig. 175. *Gregarina fragilis* Watson, × 195.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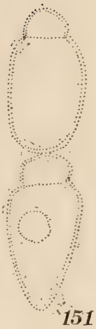
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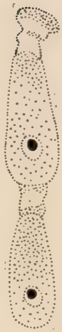
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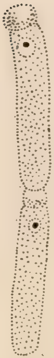
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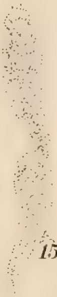
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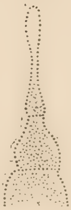
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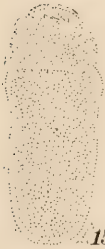
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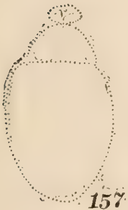
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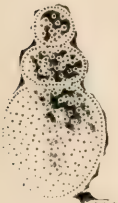
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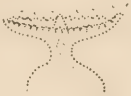
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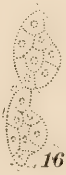
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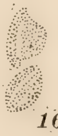
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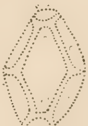
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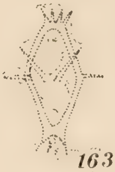
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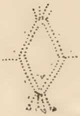
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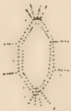
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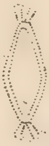
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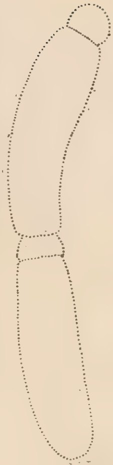
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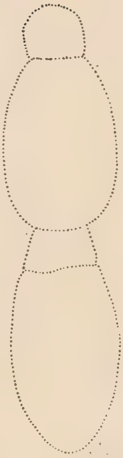
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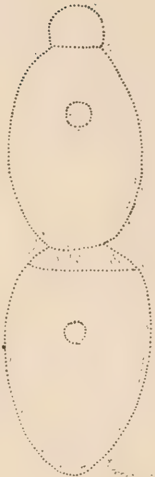
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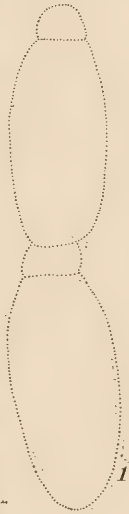
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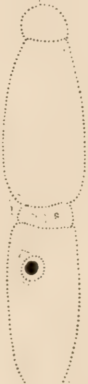
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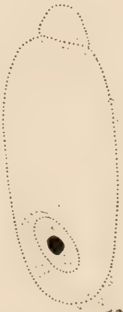
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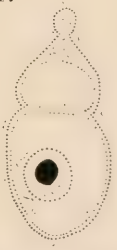
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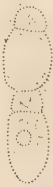
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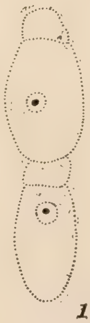
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PLATE VII

PLATE VIII

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Fig. 176. *Gregarina globosa* Watson, × 100.

Figs. 177, 178. *Gregarina oblonga* Dufour. After Dufour, 1837, Plate I, Fig. 9; Fig. 9a.

Fig. 179. Cysts of species called by Dufour *G. sphaerulosa*. After Dufour, 1837, Plate I, Fig. 4.

Fig. 180. Cysts of species called by Dufour *G. soror*. After Dufour, 1837, Plate I, Fig. 5.

Figs. 181, 182. *Gregarina hyalocephala* Dufour. After Dufour, 1837, Plate I, Fig. 8; Fig. 8a.

Fig. 183. *Gregarina ovata* Dufour. After Frantzius, 1848, Plate VII, Group IX, Fig. 1.

Fig. 184. *Gregarina blattarum* Siebold. After Schneider, 1875, Plate XVII, Fig. 11.

Figs. 185, 186. *Gregarina serpentula* deMagalhaes. After deMagalhaes, 1900, Fig. 4.

Fig. 187. *Gregarina panchlorae* Frenzel. After Frenzel, 1892, Plate VIII, Fig. 20.

Fig. 188. *Gregarina locustae* Lankester. After Leidy, 1853, Plate XI, Fig. 35.

Figs. 189, 190. *Actinocephalus fimbriatus* (Diesing) Ellis. After Leidy, 1853, Plate XI, Fig. 37; Crawley, 1907, Plate XVIII, Fig. 3.

Figs. 191, 192. *Gregarina oviceps* Diesing. After Leidy, 1853, Plate XI, Fig. 32; Crawley, 1903, Plate III, Fig. 35.

Fig. 193. *Gregarina kingi* Crawley. After Crawley, 1907, Plate XVIII, Fig. 10.

Fig. 194. *Gregarina rigida* (Hall) Ellis. After Crawley, 1907, Plate XVIII, Fig. 8.

Fig. 195. *Gregarina longiducta* Ellis. After Ellis, 1913c, Fig. 8.

Fig. 196. *Gregarina consobrina* Ellis. After Ellis, 1913b, Plate XVIII, Fig. 24.

Figs. 197, 198. *Gregarina rigida* (Hall) Ellis. After Hall, 1907, Plate I, Fig. 8; Watson, 1915, Plate II, Fig. 19.

Fig. 199. *Gregarina macrocephala* (Schneider) Labbé. After Schneider, 1882, Plate XIII, Fig. 42.

Fig. 200. *Hyalospora affinis* Schneider. After Schneider, 1882, Plate XIII, Fig. 33.

Fig. 201. *Gamocystis tenax* Schneider. After Schneider, 1875, Plate XIX, Fig. 10.

Fig. 202. *Pileocephalus blaberae* (Frenzel) Labbé. After Frenzel, 1892, Plate VIII, Fig. 24.

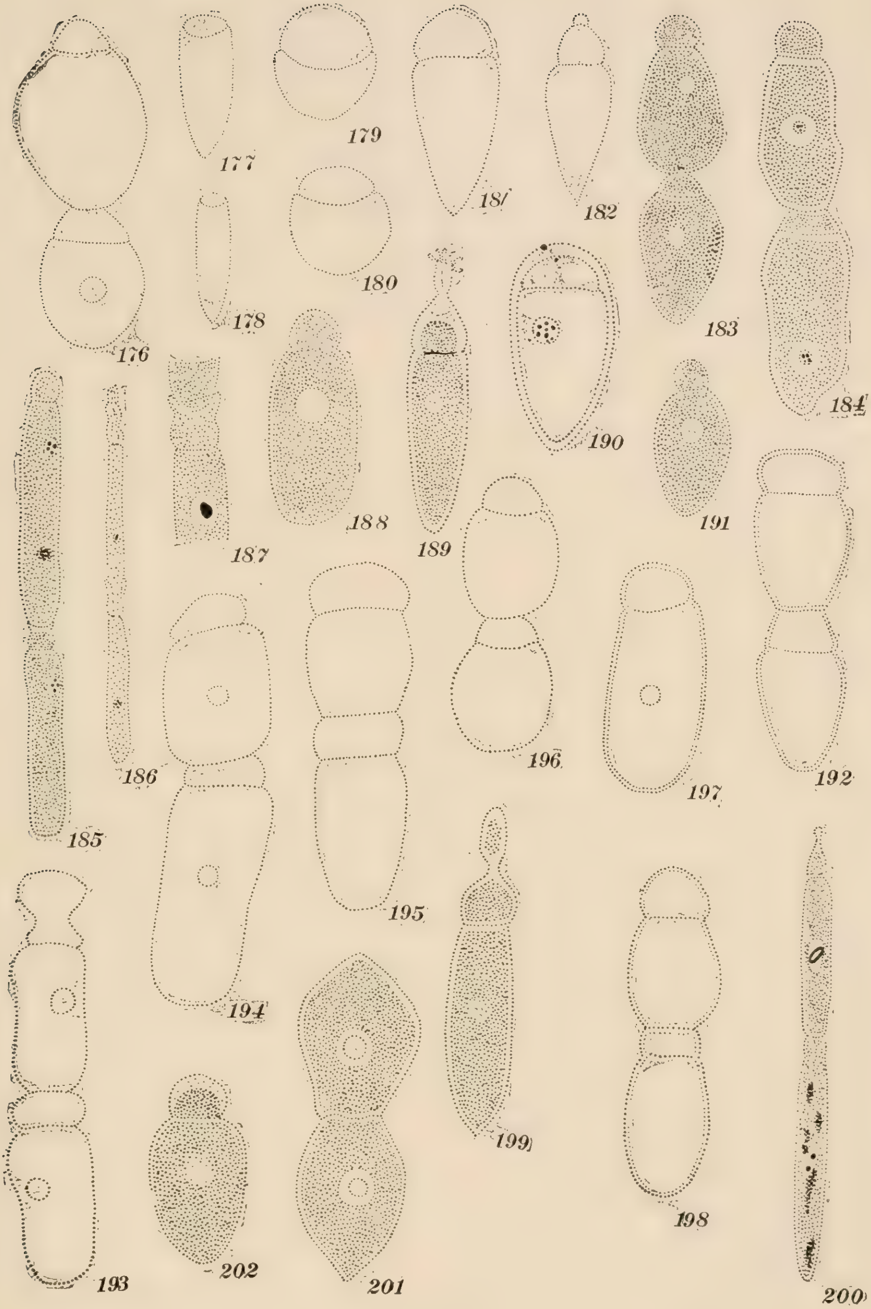
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PLATE VIII

PLATE IX

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Fig. 203. *Pileocephalus blaberae* (Frenzel) Labbé. After Frenzel, 1892, Plate VIII, Fig. 23.
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Fig. 206. *Gregarina stygia* Watson, × 245.
Fig. 207. *Gregarina illinensis* Watson, × 100.
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Fig. 209. *Leidyana gryllorum* (Cuénot) Watson. After Cuénot, 1901, Plate XX, Fig. 27.
Fig. 210. *Gregarina nigra* Watson, × 60.
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Fig. 217. *Gregarina acuta* (Léger) Labbé. After Léger, 1892, Plate VI, Fig. 10.

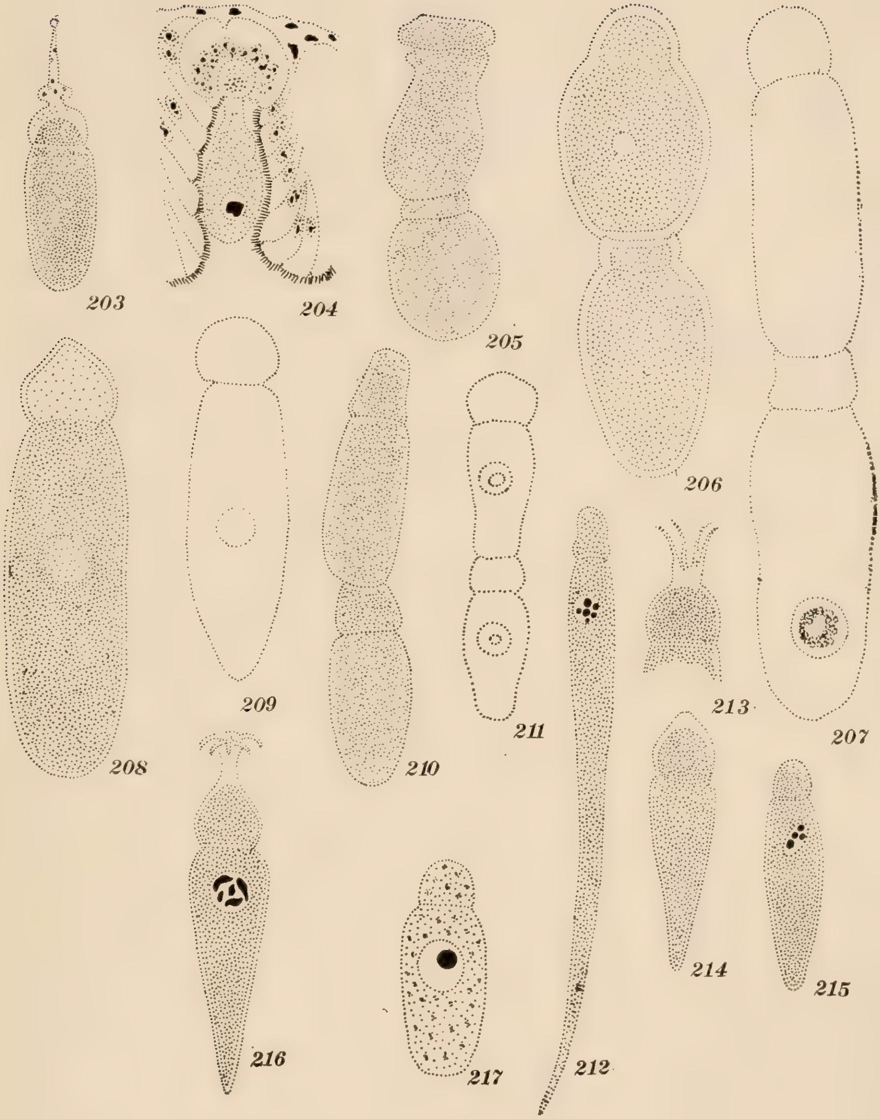
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PLATE IX

PLATE X

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Fig. 220. Another adult sporont, × 245.

Fig. 221. An old sporont, dense, compact and sluggish, just preparatory to cyst formation, × 245.

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Fig. 225. A larger trophozoite with an incipient protomerite, × 245.

Fig. 226. Fully developed but still attached trophozoites, × 245.

Fig. 227. An individual with epimerite, free in intestine and nearly as large as the adults, × 245.

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Fig. 230. A cluster of sluggish fully matured sporonts, several of which formed cysts while on the slide under observation, × 60.

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Fig. 236. A cluster of sporonts after half an hour on a slide, endeavoring to free themselves from threads at the posterior end which hold them to the debris. The sporonts are greatly stretched owing to their efforts to move forward.

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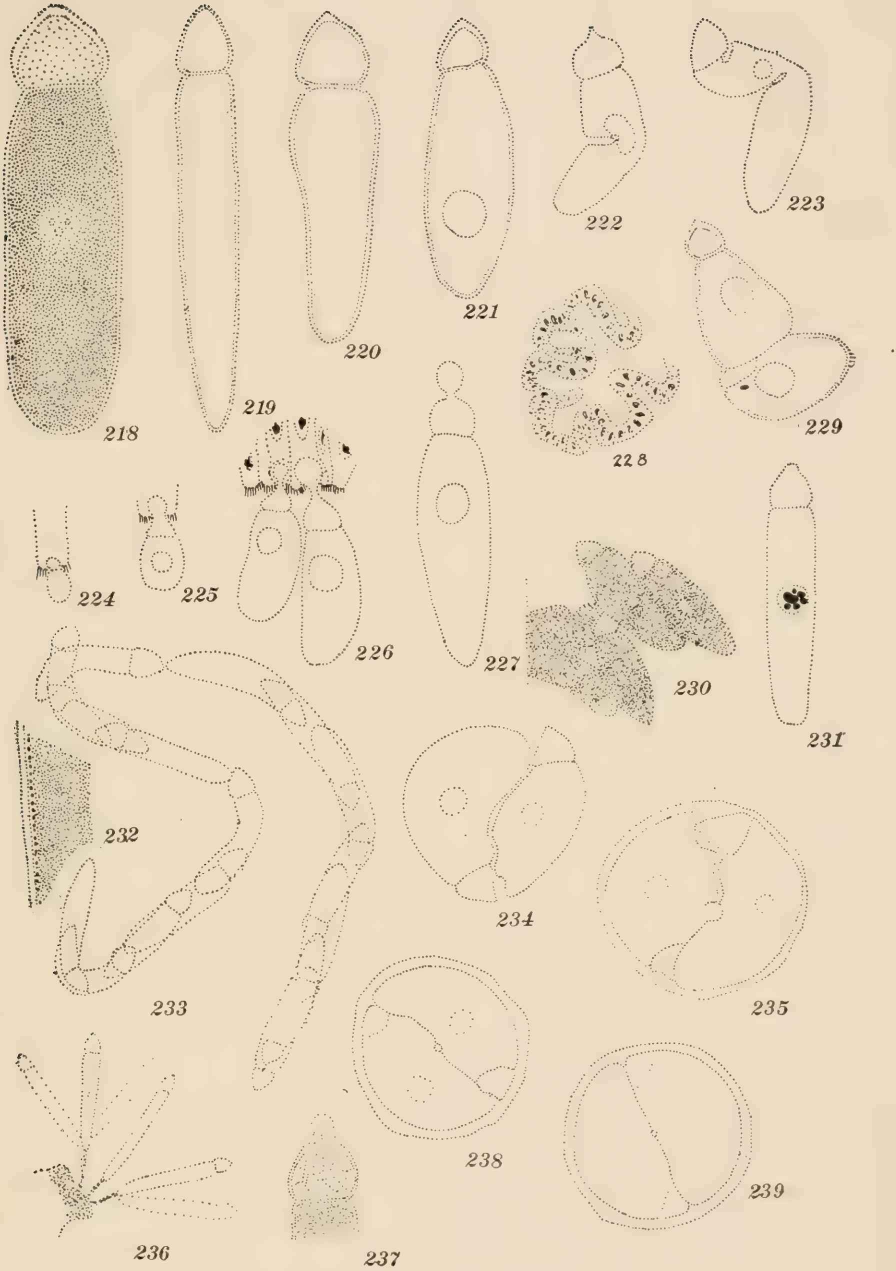

PLATE X

PLATE XI

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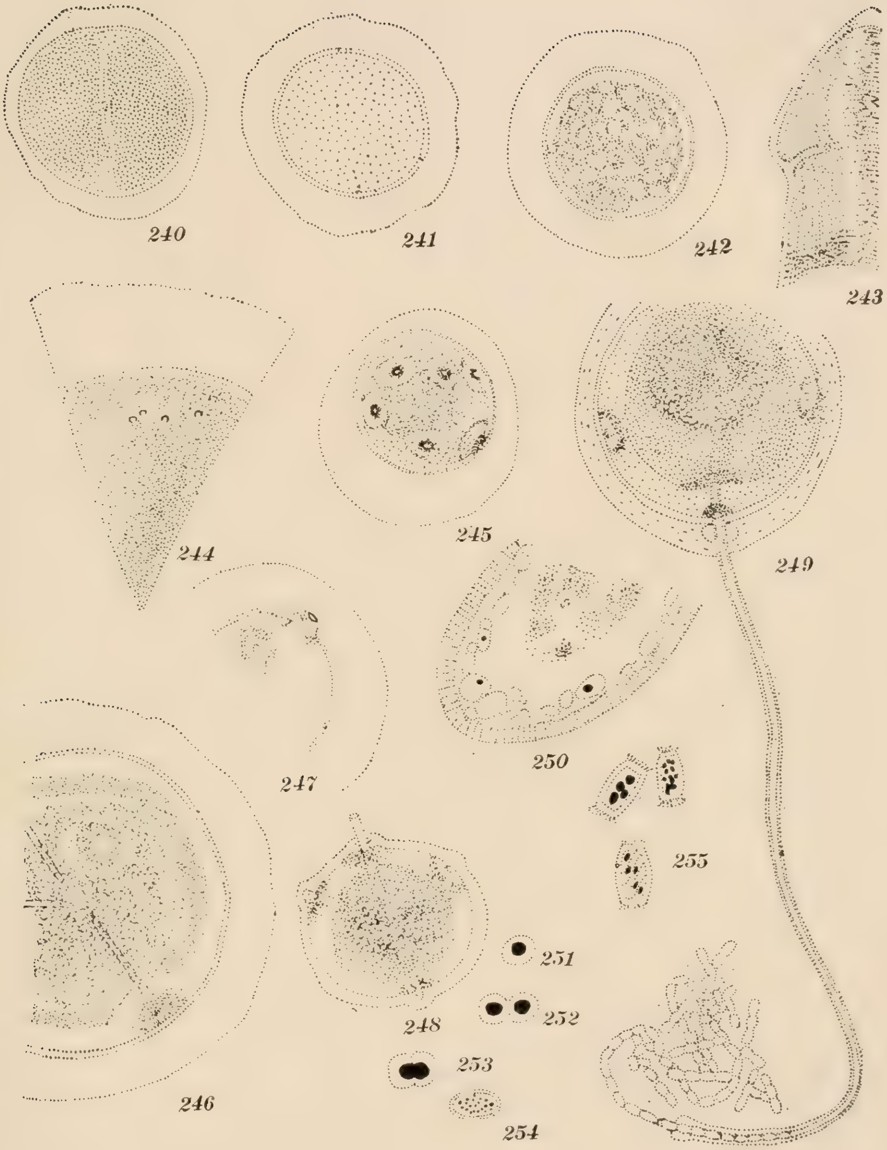
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PLATE XI

PLATE XII

EXPLANATION OF PLATE

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Figs. 273, 274. *Hirmocystis harpali* Watson. Protomerite, × 245; linking device between primite and satellite, × 245.

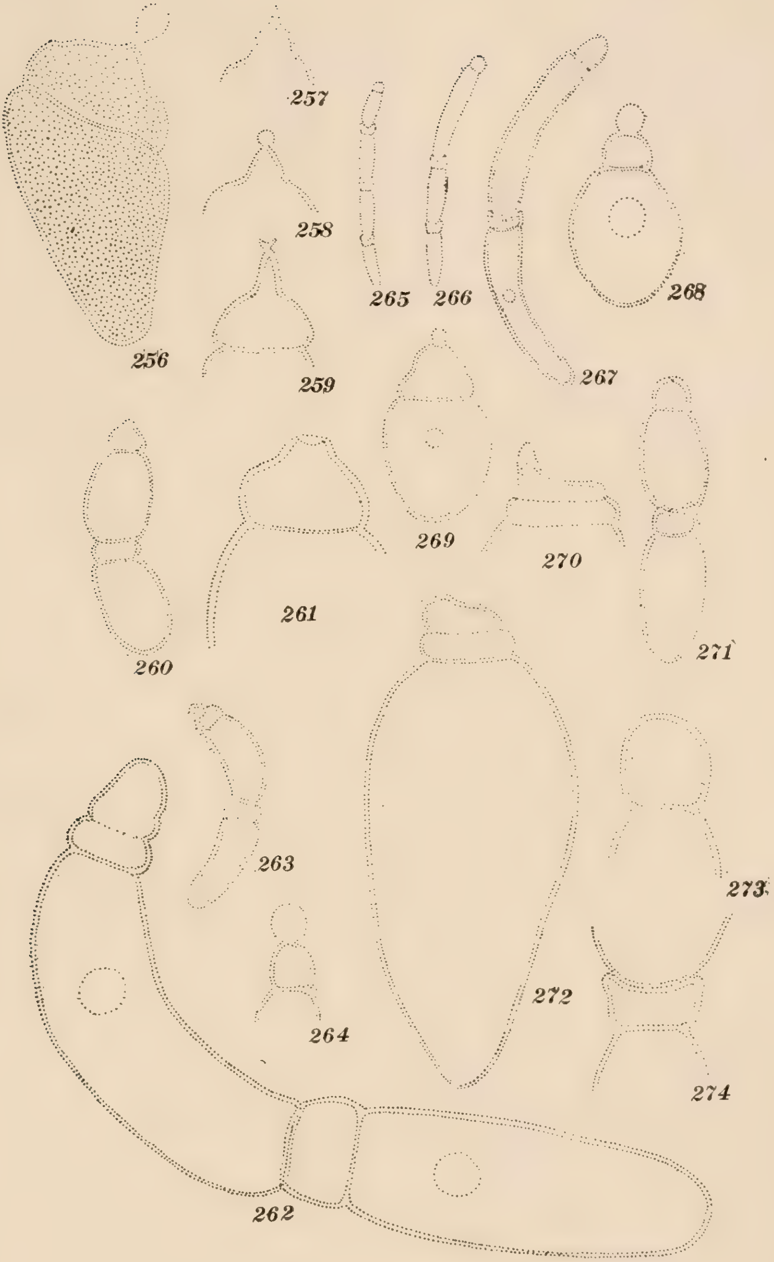
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PLATE XII

PLATE XIII

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Fig. 276. A smaller association, × 100.

Fig. 277. Association at beginning of cyst formation, sporonts beginning to rotate, × 100.

Fig. 278. Association in process of rotation, × 100.

Fig. 279. Complete cyst, still rotating, × 100.

Fig. 280. Cyst after rotation has ended, × 100.

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Fig. 288. An association from a starved host, showing the concavity in the end of the primite. × 100.

Fig. 289. A trophozoite attached to the epithelial wall of the host. × 100.

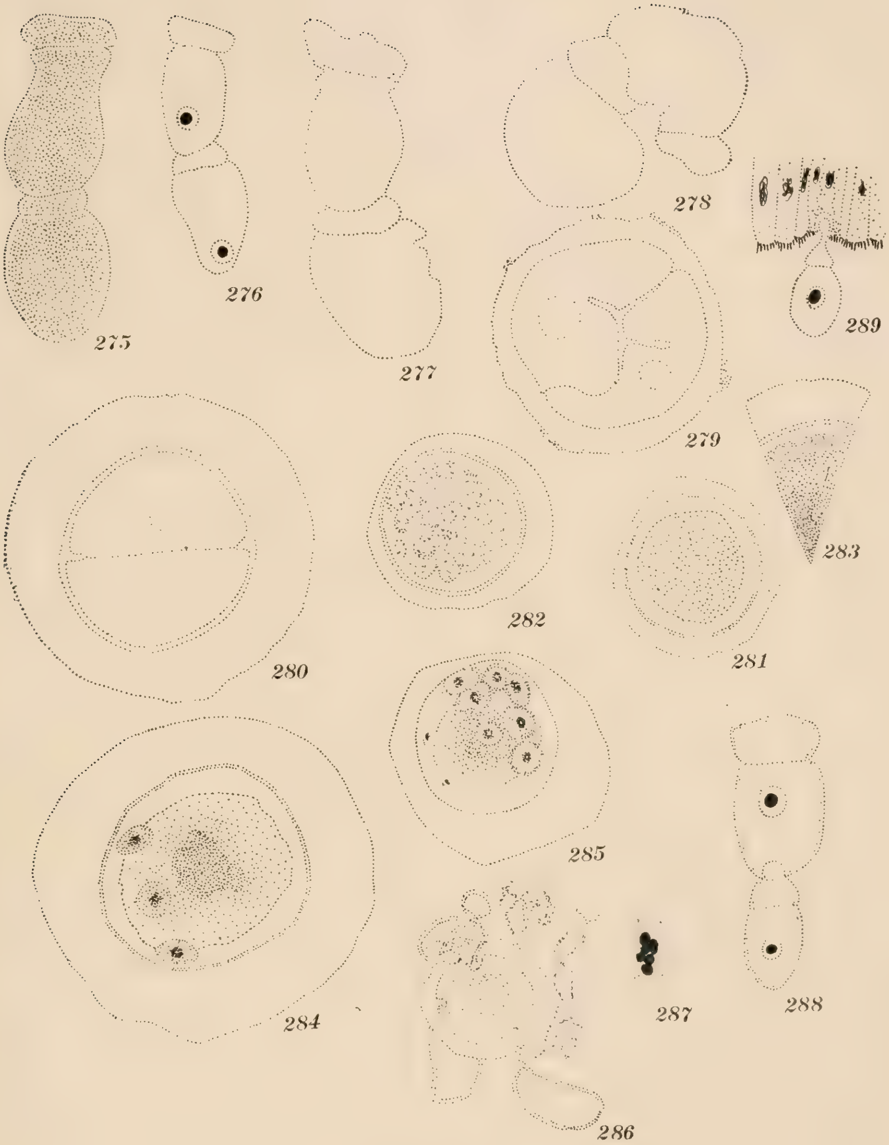
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PLATE XIII

PLATE XIV

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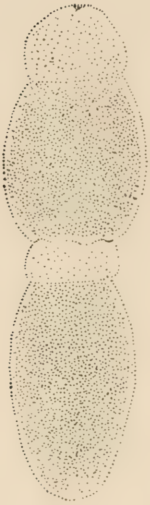
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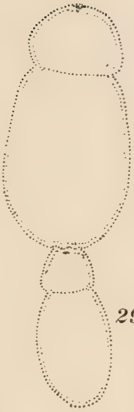
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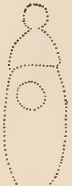
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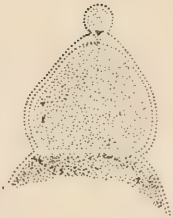
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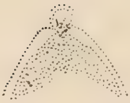
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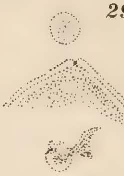
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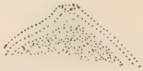
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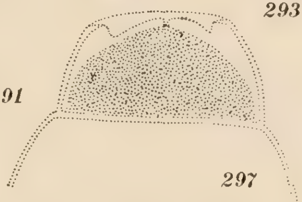
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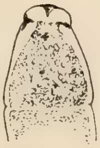
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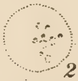
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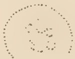
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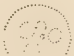
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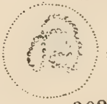
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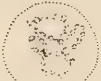
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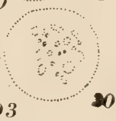
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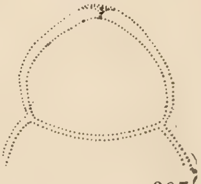
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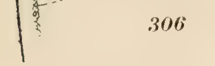
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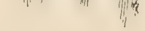
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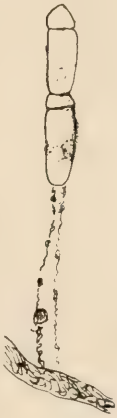
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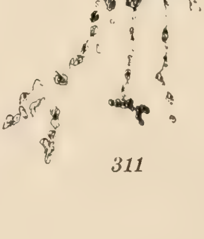
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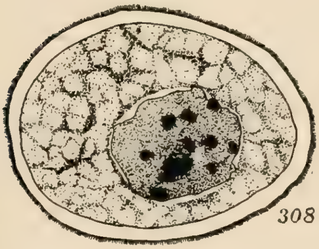
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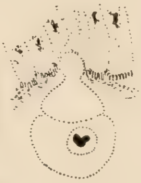
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PLATE XIV

PLATE XV

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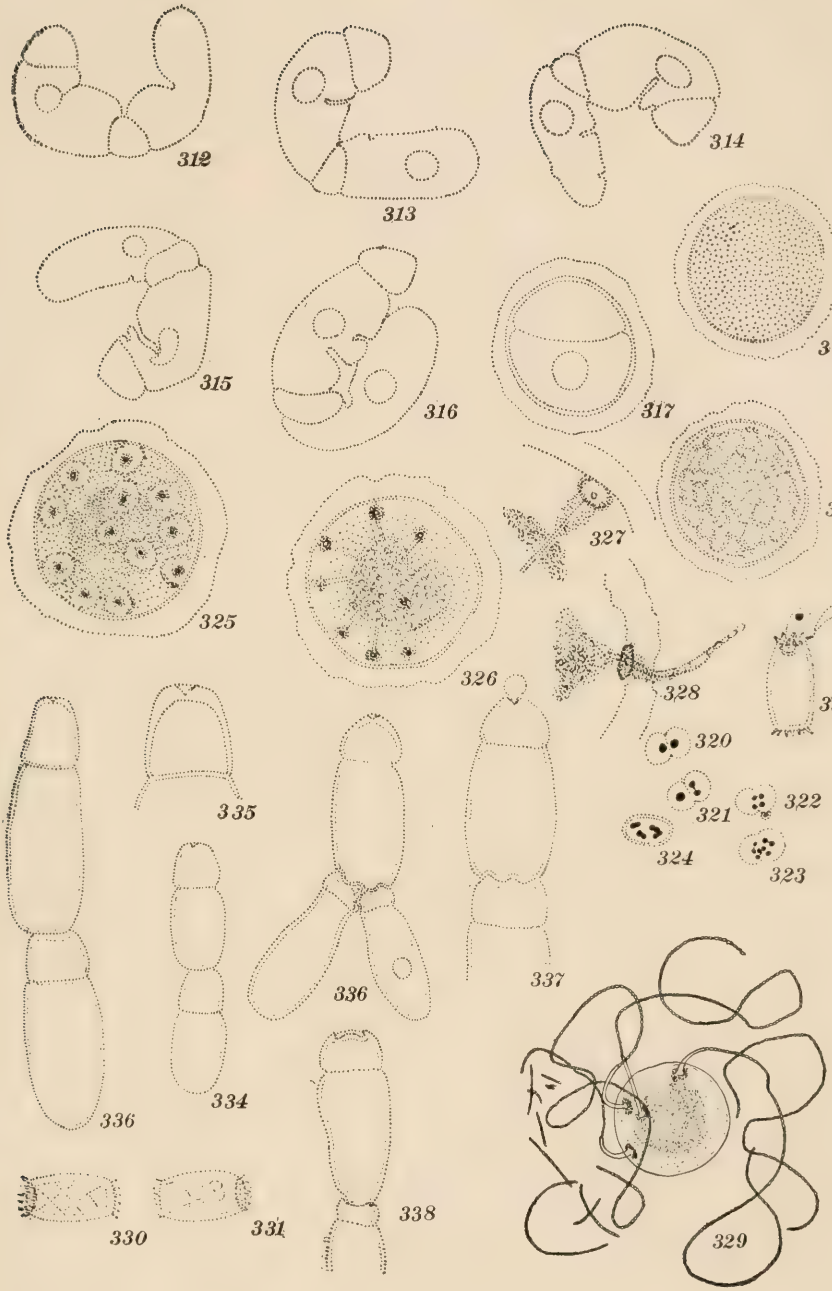
Fig. 336. Unique association of three sporonts of *G. rigida*, × 60.

Fig. 337. Unique association of *G. rigida*, the primite with an epimerite. × 60.

Fig. 338. Unique association of *G. rigida*, two satellites forming an association. × 60.



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Page 18	line 3	for *mobüszi*, read *möbuszi*
25	25	0.8, read 0.8 micron
28	30	(Fig. 70), read (Fig. 10)
29	24	*Stenaphora*, read *Stenophora*
47		transfer Genus 49 *above* Family 8 into Family 7
48	line 4	for Ulvina, read Ulivina
48	21	*virginensis*, read *virginiensis*
48	24	*Julus boleti* C. Koch, read *Julus fallax* Meinert
48	32	*Brachydesmus*, read *Brachyiulus*
49	20	1913a:286, read 1913b:286
53	2	[Figure 6], read [Figures 5 and 6]
56	34	*julu*, read *juli*
60	22	FONTARIA, read FONTARIAE
60	24	1913:53, read 1903:53
60	26	*fontaria*, read *fontariae*
61	22	*fontaria*, read *fontariae*
64	31	Fabricus, read Fabricius
69	3	1912a:8-10, read 1912b:8-10
69	18	1912:681-5, read 1912a:681-5
69	30	*Orthomorpha coarctata*, read *Parajulus* sp.
70	3	1912:685-6, read 1912a:685-6
70	5	minimum 390 micra, read maximum 390 micra
80	35	after *Scolopocryptops sexspinosus* insert *Scolopocryptops* sp.
81	7	for 1903:310-1, read 1903a:311
84	28	[Figure 32], read [Figures 32, 270, 272]
Page 90	line 1	for STRIATIUS, read STRIATUS
94	19	*Oeipoda*, read *Oedipoda*
94	20	*migratoriae*, read *migratoria*
94	36	*Schistocera, read Schistocerca*
95	3	*atlanis*, read *atlantis*
95	10	*Schistocera*, read *Schistocerca*
95	30	(Diesing) Ellis, read (Diesing) Watson
96	23	Oedipda, read Oedipoda
97	27	1845:95, read 1848:194
97	34	1904:14-18, read 1904:64-87
98	1	:: 12, read :: 1 : 2
99	35	*Blattae*, read *Blatta*
100	34	*Dissosteria*, read *Dissosteira*
101	5	Stephanohora, read Stephanophora
102	25	insert [Figure 199]
102	26	for 1875:674, read 1875:574
103	16	1892:290-300, read 1892:299-300
104	2	1893:811-13, read 1893a:811-13
104	33	1900:140-44, read 1900:40-44
108	14	*valgas*, read *valgus*
41	8	Stein, read Frantzius
68	28	*fontaria*, read *fontariae*
68	33	*fontaria*, read *fontariae*
106	8	*luridis*, read *luridus*
125	25	Stein, read Frantzius
143	11	Stein, read Frantzius

ILLINOIS BIOLOGICAL MONOGRAPHS

Vol. II April, 1916 No. 4

EDITORIAL COMMITTEE

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HENRY BALDWIN WARD

PUBLISHED UNDER THE
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THE UNIVERSITY OF ILLINOIS

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Distributed June 30, 1916

THE GENUS MELIOLA IN PORTO RICO

Including Descriptions of Sixty-two New Species
and Varieties and a Synopsis of all
Known Porto Rican Forms.

WITH FIVE PLATES

BY

FRANK LINCOLN STEVENS

Contribution from the
Botanical Laboratories of the University of Illinois

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THE GENUS MELIOLA IN PORTO RICO

The genus Meliola while not the largest or the most important genus of parasitic fungi in Porto Rico possesses features of special interest. As at present understood from the monograph of Gaillard, it constitutes a well defined, clearly marked genus with a fairly large number of species. In the Sylloge Fungorum of Saccardo 234 species and varieties are included; 63 additional species have since been described, making 297 species and varieties recognized prior to the present paper. The fungi are especially beautiful in contour, superficial with small penetrating haustoria. Usually their effect upon the host is slight though in some instances well marked pathological effects are discernible. They are among the most common genera of leaf inhabiting fungi in Porto Rico, and may be found in all parts of the island in great abundance, usually, though not always, causing conspicuous black blotches upon one or both surfaces of the leaf, more rarely upon stems.

The present study is based almost entirely upon collections made by the writer during the years 1912, 1913, and 1915. Cognizance is taken also of the collections of Heller reported by Earle. Nearly every species noted by earlier writers is included in my own collections and is usually reported upon several hosts and from numerous localities.

A narrative of the two collecting trips which furnished those specimens is given in the Journal of the New York Botanical Garden, June 1916.

A reference to the time involved has been made by Arthur.[1]

The specimens, types, cotypes, etc. of this collection have been deposited as indicated by Miss E. Young.[2] Other articles based on these collections have been published by P. Garman,[3] E. Young,[4] J. C. Arthur.[5]

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[1] Mycologia 7:168, 1915, and 8:20, 1916.

[2] Mycologia 7:143, 1915.

[3] Mycologia 7:333, 1915.

[4] Mycologia 8:42, 1916.

[5] Mycologia 7:168, 227, 315, 1915; 8:16, 1916.

The following summary will serve to give a general idea of the scope of the present report:

Total number of collections of Meliola	729
Number of species of Meliola	95
" " varieties of Meliola	6
" " new species of Meliola	56
" " new varieties of Meliola	6
" " species and varieties of Meliola new to Porto Rico	83
" " species and varieties of Meliola previously reported from Porto Rico	20
" " hosts	171
" " " previously reported	25
" " " new to Porto Rico for Meliola	146
" " host families	53
" " " " previously reported	18
" " " " new to Porto Rico for Meliola	35

In grouping the genus into sections and in keying the species I have in the main followed the plan adopted by Gaillard, laying principal emphasis upon the setae, perithecial and mycelial, next upon the character of the setal tips, and basing final specific distinction upon more minute characters of mycelium, capitate hyphopodia, spore, etc. It is to be noted that in Porto Rico occur none of the species with clavate, long, 8-spored asci. All are of the short-ascus form with two to four spores per ascus. In certain species there is constancy as regards each character, in other species there is large variation. Young colonies may be devoid of mycelial setae though they may be abundant in old colonies *(M. earlii)*. Certain species sometimes though not always present perithecial setae *(M. solani)*. Several species show large variation as to setal tips, the tips being sometimes simple and acute, sometimes slightly forked, *(M. mangiferae, M. ipomoeae)*, even much forked, and all arising from the same mycelium; or the forking may show a great range in character and complexity *(M. furcata)*. In other species the setal tips may show great constancy, e.g., *M. cucurbitacearum*. Taken all in all the problem of specific limitation is much the same as is met in the Erysiphaceae, with very similar characters to use.

The problem of classification is rendered especially difficult by the fact that the Meliolas are very often overgrown by parasites which confuse the picture and also often prevent the formation of perithecia, and, I believe, strongly influence the character of the mycelium and hyphopodia, i.e., the mycelium and hyphopodia are often made more crooked and more angular, or to appear so, by the parasite that is growing upon them. I believe also that the character of the mycelium is strongly influenced by the nature of the leaf upon which it grows, that it will be more nearly straight on a straight-veined, smooth leaf than upon a crooked-veined, hairy one.

The question of limits of variation in mycelium, hyphopodia and setae is a difficult one and finally will be solved only by inoculation experiments and observations upon live material.

I have left out of all consideration the so-called conidial stage, Helminthosporium, Podosporium, etc., because these structures appear useless in taxonomy and, moreover, because I am far from convinced that they really are conidial stages of the Meliolas. The mucronate hyphopodia are curious structures but they are so variable on the same mycelium that they possess little value in classification.

The question of biologic specialization has been but little studied in this genus. My field observation, however, strongly supports the idea that there is large specialization. For example, Cissus vines heavily coated with *M. merrillii* are found with their branches interlacing with plants susceptible to Meliola but the Cissus Meliola does not invade the other plants. The Meliolas on Dieffenbachia and Philodendron, members of the same family, to the naked eye appear much alike and under the microscope are kin, yet there is no field evidence that one goes to the other's host. In some cases forms morphologically indistinguishable are found upon large numbers of species or genera in the same family (notably *M. bicornis* on the Leguminosae), whether these forms are interinoculable or not is not known.

It is possible that were type specimens of all the old species at hand for comparison some of the new species might be found to agree with them, but from the descriptions and figures available such does not seem to be the case. It is more probable that some of the collections which I have referred to old species, relying upon printed descriptions and without comparison with types, in reality may be new species. It seems best for present purposes, however, to avoid undue multiplication of species and I believe that my error lies more largely in conservatism than in the creation of new species.

It is extremely difficult to interpret many of the descriptions that have been written, some are too brief and leave out many essentials, others describe setae but do not state whether they are perithecial or mycelial and the supposition is strong that there have been many cases where the colony character has been taken from a colony parasitized by some other fungus, e.g., many of the Meliolas described as having a crustose colony are probably Meliolas parasitized by a Microthyriaceous fungus.

The final word as to the specific relation cannot be said but with the large number of collections at my disposal, on many hosts, and the opportunity thus afforded of making close comparisons between these forms, I feel that I have at least approximated the truth.

Especially worthy of note is the occurrence in Porto Rico of several tropical species on closely related hosts, originally described from the other side of the world, notably *M. merrillii,* on Sicyos from the Philippines, *M. clavulata* on Ipomoea and *M. cyperi* on Sedges from Africa.

It should be remembered that Meliola is preeminently a tropical genus, almost exclusively so, the occurrence therefore of these species in Porto Rico, Africa and the Philippines with no present tropical land connection between these countries implies, either that the Meliolas have in the past been of different climatic range or that they are the residual flora of previously connected tropical lands.

I wish to acknowledge the very great assistance that I have received from Doctor N. L. Britton and Mr. Percy Wilson in the determination of Phanerogamic hosts, from Miss Slosson, the Pteridophytes, and from Mrs. Agnes Chase the Grasses.

Meliola, Key to Sections

Spores 3-septate, mycelial setae none	section A, p. 10
Spores 4-septate	
Mycelial setae none	
Perithecium with no setae or appendages	section B, p. 12
Perithecium with setae or with appendages	section C, p. 20
Mycelial setae present	
Perithecium with setae or appendages	section D, p. 32
Perithecium with no setae or appendages	
Mycelial setae simple, straight	section E, p. 34
Mycelial setae simple, uncinate	section F, p. 52
Mycelial setae usually simple, sometimes forked	section G, p. 54
Mycelial setae forked	section H, p. 57

SECTION A

Spores 3-septate, mycelial setae none

The members of this section are clearly marked by the 3-septate spores, a character that seems to be invariable, and the three species found in Porto Rico are clearly limited as is shown in the following key.

KEY TO SPECIES OF SECTION A

Perithecium with larvaeform appendages	M. puiggarii	No. 1
Perithecium with no larvaeform appendages		
Perithecial setae absent	M. manca	No. 2
Perithecial setae present,	M. guignardi	No. 3

There is quite a striking similarity between the hyphopodia upon the three species with 3-septate spores. They are of the same general size and contour, large and irregular.

1. M. puiggarii Speg.

Fungi Puiggariani. No. 228.
On *Rubus* sp. Fig. 1.[1]

El Alto de la Bandera, July 15, '15, *8650*, July 14, '15, *8270*. Maricao, July 20, '15, *8892*.

No other species has been reported upon the Rosaceae. The form agrees well with the descriptions and with a type specimen, No. 2722, received from Dr. Spegazzini, though the perithecial appendages are nearly twice as long as stated. See also under *M. manca*.

2. Meliola manca Ell. and Mart.

Amer. Nat. 17: 1284, 1883, and Jour. Myc. 1: 148, 1885.
On *Myrica cerifera* L. Fig. 2.

Manati, Nov. 23, '13, *5289*, Nov. 25, '13, *5250*. A collection by Heller near Cataño, Jan. 17, '03.

In ''Le Genre Meliola'', Gaillard unites under *M. manca* the three species *M. manca, M. sanguinea,* and *M. puiggarii,* giving a new description for *M. manca*. This new description mentions larvaeform, perithecial appendages. The original description of *M. manca* by Ellis and Martin mentions no such appendages, but does specifically state that there are no perithecial appendages. My own material of two collections is ample. I have studied it carefully, also a specimen of the Heller collection and a specimen collected by Martin and distributed by Ellis as N.A.F. No. 1292, all of these upon the same host. These specimens all agree perfectly and agree with the original description. They do not have larvaeform perithecial appendages and therefore do not conform with the description as given by Gaillard.

The specimens of Meliola which I have found on Rubus agree well with the description of *M. puiggarii*. They have abundant larvaeform appendages and cannot be placed under *M. manca*. Moreover, both the general characters of the mycelium and of the capitate hyphopodia separate the forms on Rubus from those of Myrcia, the hyphopodia on Rubus being much larger and more irregular in shape. I am forced therefore, to regard the description given by Gaillard for *M. manca* as erroneous and that of Ellis and Martin as correct and to recognize *M. puiggarii* on Rubus, as an entirely different species.

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[1] Figures accompanying this article are noted in connection with the host from which they were made.

In the head cell of each capitate hyphopodium there is a small, clear spot, about 3μ in diameter, which appears to be a hole in the lower side of the hyphopodium, and if so probably indicates the breaking off of a haustorium. Similar marks are found upon the capitate hyphopodia in many species but they are not usually so conspicuous as in this species.

3. M. GUIGNARDI Gaill.

Bull. Soc. Myc. de France 8: 176, 1892.

On *Turpinia panniculata* Vent. Fig. 3.

Maricao, July 19, '15, *8922*, Sept. 20, '13, *3685*.

This differs somewhat from the type as described by Gaillard in its smaller perithecia, about 300μ, shorter perithecial setae, about 100-150μ, and smaller ascospores, 54 x 15μ.

It is of special interest since it is the only species known which has a 3-septate spore, without mycelial setae, and with perithecial setae. The hyphopodia are very characteristic and agree well with the figures of Gaillard. The type of the species was from Ecuador on host unknown.

SECTION B

Spores 4-septate, no setae or appendages

This section corresponds to the Section I C. a. of Gaillard without the forms with perithecial appendages. As represented in Porto Rico it presents many puzzling aspects, occurring on a large number of hosts of many families and presenting variations which though easy to recognize are difficult to define with accuracy. The spores in all are quite uniform and neither in size, shape nor constriction lend themselves to description. There are no perithecial or mycelial setae. Therefore the perithecium, the mycelium and hyphopodia must furnish the distinctions. Moreover, such variations as do occur in the perithecium are minor and difficult to state definitely. For this reason many students have referred such forms on numerous hosts to *M. glabra*. A study of the Porto Rican material both in the field and under the microscope convinces me that many of these forms which may agree in spores and perithecia and which show variation in general habit in mycelium and hyphopodia are really distinct species. Plants heavily infected with one of these forms of Meliola may be found growing among plants susceptible to another form, but which are entirely devoid of Meliola.

In the treatment of the Porto Rican species I have removed from *M. glabra* all which it seems very evident are not co-specific with the specimen No. 3849 of Rabenhorst's Fungi Europaei. I have described some Meliolas as varieties though I am inclined to believe that in several instances they will eventually prove to be really as distinct specifically as many other forms that are recognized as species.

Key to Species of Section B

Mycelium very dense, close woven	
Spore cells about equal in size	
Head cell oval or slightly angular	M. glabra No. 4
Head cell angular to lobed	M. sepulta No. 5
Spore cells unequal	M. irregularis No. 6
Mycelium not close woven	
Capitate hyphopodia mostly opposite	M. solani No. 7
Capitate hyphopodia not opposite	
Mycelium more or less crooked	
Mycelium wavy	
Capitate hyphopodia oval	M. hyptidicola No. 8
Capitate hyphopodia globular	
Perithecia very rough	M. cyclopoda No. 9
Perithecia not very rough	M. aibonitensis No. 10
Mycelium very crooked	
Capitate hyphopodia angular	M. perseae No. 11
Mycelium usually straight or nearly so	
Capitate hyphopodia entire	
Oval, small, 17 x 7μ	M. laguncularia No. 12
Elliptical, large, 21 x 10μ	M. longipoda No. 13
Pyriform	M. melastomacearum No. 14
Capitate hyphopodia entire or lobed	M. glabroides No. 15
Capitate hyphopodia lobed	M. triloba No. 16

4. Meliola glabra Berk. and Curt.

Cuban Fungi N. 883 *(pro parte).*
Gaillard, Le Genre Meliola: 59: 1892.

On *Hypelate trifoliata* Sw.

Mona Island, collected by Britton, Cowles and Hess, Feb. 1914.

Two other specimens were also sent to me by Dr. Britton from the Bronx Herbarium, one from the Bahamas, No. 8246, one from Cuba, No. 2171, collected in 1860-1864.

On *Drypetes* sps.

Rio Tanama, July 6, '15, *7885.*

This specimen shows an unusually rough, irregular mycelium and capitate hyphopodia.

If we accept for *M. glabra* the description given by Gaillard and as belonging to it the specimen distributed by Rabenhorst and Winter as No. 3849, Fungi Europaei (See Fig. 4) on *Barbacenia purpurea* we must think of this as a form with a dense, closely matted mycelium with mycelial threads coursing more or less parallel. This is typically the condition of the Meliola on Hypelate.

4a. Meliola glabra var. psychotriae var. nov.

There is a remarkable variation here in that many of the colonies are very small, of rapidly branching, closely matted mycelium, while others are of looser structure and larger in area.

The small, closely matted colonies approach quite closely to the type while the loose colonies deviate from it widely.

On *Palicourea domingensis* (Jacq.) DC.

Florida Adentro, July 1, '15, *7649* (type).

On *Psychotria bertiana* P.

El Alto de la Bandera, July 15, '15, *8673*, *8654*, *8278*, *8710*, *8566*, *8646*. El Gigante, July 17, '15, *8528*.

On *Psychotria pubescens* Sw.

Arecibo - Lares Road, June 21, '15, *7281*. Vega Baja, July 2, '15, *7732*, July 2, '15, *7741*. Dos Bocas, below Utuado, July 8, '15, *8032*.

On *Psychotria grandis* Sw.

Mayaguez, June 25, '15, *7487*.

On *Psychotria* sp. Quebradillas, Nov. 22, '13, *5032*.

Vega Baja, Mch. 1, '13, *516*.

On *Palicourea* ?

Mayaguez, May 1, '13, *1070* b. Jan. 30, '13, *316*. Vega Baja, Feb. 20, '13, *468*. Dos Bocas, below Utuado, Dec. 30, '13, *6650*. El Gigante, Dec. 15, '13, *5944*. Ponce, Nov. 8, '13, *4367*. Maricao, July 20, '15, *8875*.

On *Coccocypselum repens* Sw.

Maricao, July 20, '15, *8961*.

5. Meliola sepulta Pat. in herb.

On *Avicennia nitida* Jacq. Fig. 5.

Two specimens were collected by Heller, Nos. *390*, Jan. 31, '89, *6416*, Jan. 17, 1903; both of these in the Bronx Garden bear the above name, but description has not yet been published. The following description is made from a fragment of specimen No. 390 which becomes the type:

Colonies circular, 1-7 mm. in diam., black, dense, mostly hypophyllous, mycelium closely branched, producing a closely woven mat. Capitate hyphopodia 24 x 14μ, opposite or alternate, head cell angular or often distinctly lobed, stalk cell 10μ long. Mycelial and perithecial setae none. Perithecia abundant in older portions of the colony, 170μ in diam., slightly rough. Asci evanescent, short, thick, 2-4 spored. Spores, 52 x 20μ, strongly constricted, ends obtuse.

6. Meliola irregularis sp. nov.

Colonies amphigenous, irregular, 1-3 mm. in diam., black. Mycelium forming a very close network of threads which branch irregularly, 7μ in diameter. Hyphae often so close as to lie in contact forming a mat.

Capitate hyphopodia alternate or irregular, crowded, head cell pyriform, somewhat irregular, 17 x 10μ, the basal cell 3-7μ long, Mucronate hyphopodia alternate or opposite, bottle-shaped, narrow, 20μ long. Mycelial setae none. Perithecial setae none.

Perithecia 200μ, rough with conic protuberances about 17μ high. Asci 2-spored, soon evanescent; ascospores 4-septate, brown, constricted, obtuse, 41 x 14μ, often irregular in shape, one end pointed, one or more cells larger than the others, or with septa set obliquely, occasionally with an aberrant number of septa.

On *Hygrophila brasiliensis,* (Spreng.) Lind. Fig. 6.

Rio Piedras, Aug. 11, '15, *9283* (type).

This species in character of perithecium resembles *M. glabra* but in spores and mycelium it is quite different.

7. Meliola solani sp. nov.

Colonies amphigenous, irregularly circular, 2-4 mm. in diam. Mycelium black, forming a close network, 7μ in diameter, branches irregular.

Capitate hypophodia small, mostly opposite, not crowded, 2 per cell, cells about 17μ long, head cell pyriform or globular, 10 x 8μ, the basal cell short. Mucronate hyphopodia few, alternate or opposite, bottle-shaped, 14 x 7μ. Mycelial setae none. Perithecial setae few or wanting, straight or slightly curved, 125 x 7μ, tip obtuse, dark.

Perithecia 150-180μ. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 37 x 14μ.

On *Solanum jamaicense* Mill. Fig. 7.

Monte de Oro, Dec. 3, '13, *5750* (type).

The chief, distinguishing character is the small, nearly globular capitate hyphopodia which are usually opposite.

8. MELIOLA HYPTIDICOLA sp. nov.

Colonies amphigenous, chiefly hypophyllous, irregular, diffuse. Mycelium black, forming a loose network, 7μ in diameter, branches irregular.

Capitate hypophodia small, alternate or irregular, not crowded, 1 per cell, cells about 20μ long, head cell ovoid, 14-17 x 9μ, the basal cell 3-6μ long. Mucronate hyphopodia few, bottle-shaped. Perithecial setae none. Mycelial setae none.

Perithecia 100-140μ, slightly rough. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 31-34 x 10-13μ.

On *Hyptis lantanifolia* Poit.

Las Marias, July 10, '15, *8130* (type).

On *Hyptis capitate* Jacq. Fig. 8.

El Gigante, July 16, '15, *8526*.

On *Hyptis pectinata* (L.) Poit.

Dos Bocas, below Utuado, July 7, '15, *7981*. Maricao, July 19, '15, *8791*.

On *Hyptis* sps.

Monte de Oro, Dec. 13, '13, *5760*.

9. MELIOLA CYCLOPODA sp. nov.

Colonies epiphyllous, circular, 1-5 mm. in diam. Mycelium black, forming a loose network, 7μ in diameter, branches mostly opposite.

Capitate hyphopodia small, alternate, not crowded, 1 per cell, cells 20 to 35μ long, head cell nearly globular, 14 x 14μ, the basal cell 3-7μ long. Mucronate hyphopodia opposite, bottle-shaped, 10-18 x 6μ. Perithecial setae none. Mycelial setae none.

Perithecia 135-170μ in diam., rough with conic protuberances. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 38 x 14μ.

On *Pseudelephantopus spicatus* Juss. Fig. 9.

Vega Baja, July 2, '15, *7733* (type), *7871*.

10. MELIOLA AIBONITENSIS sp. nov.

Colonies amphigenous, black, circular to irregular, 1-3 mm. in diam. Mycelium rather closely woven, crooked, waving, branching irregular.

Capitate hyphopodia alternate or unilateral, rather close together, often 17μ, head cell nearly globular, 10-15μ in diam., stalk cell short. Mucronate hyphopodia scattered, bottle-shaped to conic. Mycelial and perithecial setae none.

Perithecia flattened when young and somewhat so when mature, surrounded by an areola of radiating mycelium, slightly rough, 140μ in diam., spores 4-septate, 41 x 17μ, obtuse, slightly constricted.

On unknown dicotyledonous host, Aibonito, July 16, '15, *8470*.

11. MELIOLA PERSEAE sp. nov.

Colonies hypophyllous, irregular, black, 2-5 mm. in diam. Mycelium very crooked, branching irregularly, opposite, alternate or dichotomous, very dark, 9μ thick.

Capitate hyphopodia alternate or irregular, head cell oval to pyriform, cuneiform or angular. Mucronate hyphopodia alternate, variable. Mycelial setae none. Perithecial setae none.

Perithecium 100-200μ in diam., black, very rough with large conical projections. Asci evanescent. Spores 4-septate, strongly constricted, dark brown, ends rounded, 44 x 24μ.

On *Persea gratissima* Gaertn. Fig. 10.

Las Marias, July 10, '15, *8212* (type).

Characterized chiefly by absence of setae and its very irregular mycelium; near to *M. calva* but differing from it in its rough perithecium.

12. MELIOLA LAGUNCULARIAE Earle

Muhlenbergia 1: 11, 1901.

On *Laguncularia racemosa* (L.) Gaertn.

Mayaguez, June 27, '15, *7505*, April 20, '13, *1364*. Martin Peña, Aug. 11, '15, *9331*. Joyuda, 331, '13, *363*.

The type was collected by Heller on the same host Jan. 1900, No. *4361*a. Another collection was made by Heller at Cataño, Jan. 7, '03, No. *6417*.

13. MELIOLA LONGIPODA Gaill.

Bull. Soc. Myc. de. Fr. 8: 172, 1892.

On *Cordia* sp.

Mayaguez Mesa, June 25, '15, *7472*.

On *Cordia nitida* Vahl. Fig. 11.

Martin Peña, Aug. 11, '15, *9329*.

The hyphopodia in these specimens seem quite variable. In No. *7472*, they are long, especially long in the stalk cell. The capitate hyphopodia do not agree precisely with the figures of Gaillard. They are more commonly obtuse or even truncated; nor are they quite as long as is called for in Gaillard's description. Still, in view of the evident variability of these structures in this species, it seems best to regard my collections as *M. longipoda*.

On *Tournefortia hirsutissima* L.

Rio Arecibo, K. 64.7, July 8, '15, *7780*. Dos Bocas, below Utuado, July 7, '15, *7965*. Quebradillas, Nov. 22, '13, *5001*.

These specimens agree closely with the descriptions and drawings of Gaillard.

On *Anona montana* Macf.

Mayaguez, June 29, '15, *7561*.

14. MELIOLA MELASTOMACEARUM Speg.

Fung. Puigg., N. 232.

On *Clidemia hirta* (L.) D. Don. Fig. 12.

Maricao, July 20, '15, *8956*. Mayaguez, June 24, '15, *7394*. Las Marias, July 10, '15, *8123*. Dos Bocas, below Utuado, July 8, '15, *8089*, Aug. '15, *9479*.

On *Clidemia strigillosa* (Sw.) P. DC.

Trujillo Alto, Aug. 15, '15, *9423*. Lajas, June 17, '15, *7159*.

On *Miconia laevigata* (L.) P. DC.

Dos Bocas, below Utuado, July 8, '15, *8085*. Rio Arecibo, K. 64.7, July 8, '15, *7797*. El Alto de la Bandera, July 15, '15, *8662*.

On *Miconia racemosa* (Aubl.) P. DC.

Mayaguez, June 24, '15, *7414*, *7399*, *7389*, June 16, '15, *7636*, June 14, '15, *7037*. Lajas, June 17, '15, *7145*.

The colonies of this fungus are very inconspicuous, so much so that in probably no case was the collection made for the Meliola; that is, in nearly every case the leaves were collected for other fungi upon them, chiefly Microthyriaceae, and it was only when the specimen came under the compound microscope that the presence of the Meliola was recognized. Indeed after it is known that the Meliola is present it is often very difficult to locate the colonies amid the large numbers of other fungi which are usually found upon these hosts. The fungus agrees fully with authentic specimens received from Dr. Spegazzini.

15. MELIOLA GLABROIDES sp. nov.

Colonies amphigenous, mostly epiphyllous, irregular, circular, 1-8 mm. in diam. Mycelium black, forming a loose network, 7μ in diameter, branches mostly opposite, often at right angles.

Capitate hyphopodia alternate, not crowded, 1 per cell, cells about 30μ long, head cell ovoid, entire or angular, $17 \times 14\mu$, the basal cell 7μ long. Mucronate hyphopodia few, alternate or opposite, bottle-shaped, $16\text{-}18 \times 6\mu$. Perithecial setae none. Mycelial setae none.

Perithecia $100\text{-}140\mu$, rough with rounded protuberances. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, $41 \times 17\mu$.

On *Piper adunctum,* L. Fig. 13.

Indiera Fria, Maricao, Oct. 8, '13, *3371* (type). El Alto de la Bandera, July 15, '15, *9039*, *8633*. Las Marias, July 10, '15, *9603*, *8133*. Dos Bocas, below Utuado, July 8, '15, *8064*. Vega Baja, July 2, '15, *7724*. Mayaguez Mesa, June 29, '15, *7563*. Añasco, Oct. 12, '13, *3582*. Maricao, Sept. 20, '13, *3647*, Nov. 8, '13, *4802*. Arecibo-Lares road, June 21, '15, *7297*. Aibonito, July 16, '15, *8471*. Lares, Nov. 22, '13, *4930*. Martin Peña, Aug. 11, '15, *9334*. Trujillo Alto, Aug. 16, '15, *9472*. Utuado, Nov. 8, '13, *4393*.

A specimen in the Bronx Gardens, Number 4359 a. on *Piper adunctum* was collected at Mayaguez, P. R., Jan. 23, 1900, and determined as *M. glabra.* Of the various species of Meliola found on Piper it can be readily distinguished by the absence of setae and by the prominent roughening of the perithecium. The species is very common on its widespread host. No injury to the leaves is apparent.

On *Nectandra patens* (Sw.) Griseb.

Mayaguez Mesa, June 25, '15, *7466*, June 15, '15, *7081*, June 29, '15, *7595*. Maricao, Sept. 20, '13, *4852*, July 20, *8873*, *8874*, *8867*, July 19, '15, *8750*, July 20, '15, *8973*.

On *Simarubra tulae* Urb.

Mayaguez Mesa, June 29, '15, *7588*. Mayaguez, June 15, '15, *7061*. El Gigante, near Adjuntas, July 16, '15, *8516*.

On *Sauvagesia erecta* L.

El Alto de la Bandera, July 15, '15, *8641*. Las Marias, July 10, '15, *8129*. Maricao, July 19, '15, *8944*, *8777*.

A specimen determined by Earle as *M. glabra* is in the Bronx Gardens. The form on this host uniformly shows shorter, more nearly globular capitate hyphopodia than are found in the type.

On *Stachytarpheta cayennensis* (L. Cl. Rich) Vahl.

Trujillo Alto, Aug. 15, '15, *9405*. Sabana Llana, Aug. 13, '15, *9380*.

I would add here also specimen No. 6402, Pueblo Viejo, of Heller, Jan. 13, 1903, which is in the Bronx collection under the name *M. cookeana,* an evident error of determination. This form, like the last, also has short head cells. Its mycelium is also less straight than in other specimens of this species.

On *Solanum rugosum* Dunal.

Las Marias, July 10, '15, *8121*.

On *Solanum persicifolium* Dunal.

Quebradillas, Nov. 22, '13, *5019*.

This has short hyphopodia, similar to those of the two last mentioned.

15a. Meliola glabroides, var. schlegeliae var. nov.

This differs from the type in its more angular capitate hyphopodia and a some what closer colony structure.

On *Schlegelia sps.*

El Alto de la Bandera, July 14, '15, *8289* (type), *8274.*

16. Meliola triloba Wint.

Hedw. 25: 95, 1886.

On *Pilea parietaria* (L.) Bl. Fig. 14.

Arecibo-Lares Road, June 21, '15, *7232.* Dos Bocas, below Utuado, July 8, '15, *1038.* Rio Arecibo, K. 64.7, July 8, '15, *7804.*

Also reported by Earle as No. 558 of Heller's collection, 1899. This and *M. earlii* are often associated upon the same leaves but the present species is usually epiphyllous.

SECTION C.

Spores 4-septate, no mycelial setae, perithecia with setae or appendages.[1]

Key to Species of Section C

Appendages larvaeform	
Capitate hyphopodia distant, 27μ	
Head cell angular or entire	
Appendages long	M. compositarum No. 17
“ short	M. tuberculata No. 18
Head cell very irregular	M. calophylli No. 19.
Capitate hyphopodia close, 17μ	M. arecibensis No. 20
Appendages setiform	
Mycelium very scant, (Distance between mycelial threads more than ten times the thickness of the threads)	
Head cells not usually globular	M. miconieicola No. 21
Head cells mostly globular	M. tenuissima No. 22
Mycelium not very scant	
Capitate hyphopodia crowded	M. parathesicola No. 23
Capitate hyphopodia not crowded	
Tips of setae much curved	
Tips often hooked, uncinate	
Mycelium wavy	M. toruloidea No. 24
Mycelium nearly straight	M. comocladiae No. 25
Tips often coiled or spiral	M. tortuosa No. 26

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[1] *M. solani,* see p. 15, might sometimes fall within this section.

Tips of setae slightly curved or not at all	
Setae very thin, 4μ	M. chamaecristicola No. 27
Setae thicker	
Branches quite uniformly at right angles	
Head cell not angular	M. rectangularis No. 28
Head cell angular	M. chicoccae No. 29.
Branches not at right angles	
Main mycelial threads running parallel	M. pteridicola No. 30
Main mycelial threads not parallel	
Setae thick, 10μ, heavy walled	M. molleriana No. 31
Not as above	
Setae long, 125μ	
Spores $37 \times 14\mu$	M. cupaniae No. 32
Spores $50 \times 14\mu$	M. ocoteae No. 33
Setae not so long	
Colony very dense, threads agglutinated	M. compacta No. 34
Colony dense, threads not agglutinated	M. miconiae No. 35
Colony not dense	
Head cell nearly globular	M. triumfettae No. 36
Head cell not globular	M. maricaensis No. 37

17. MELIOLA COMPOSITARUM Earle

Bull. N. Y. Bot. Gard. 3: 306, 1905.

On *Eupatorium odoratum* L. Fig. 15

Dos Bocas, below Utuado, July 8, '15, *7977*, *8055*, Dec. 16, '13, *6056*, *6001*, Dec. 30, '13, *6574*. El Gigante, July 10, '15, *8537*. Arecibo-Lares Road, June 6, 21, '15, *7309*. El Miradero, Aug. 4, '15, *9168*. Florida Adentro, July 1, '15, *7689*. Las Marias, July 10, '15, *8155*. Rio Tanama, July 6, '15, *7825*. Maricao, July 19, '15, *8798*. Aibonito, July 16, '15, *8466*. Rosario, Nov. 27, '13, *3771*. Utuado, Nov. 8, '13, *4683*. Mayaguez, Oct. 31, '13, *3898*. Yauco, Oct. 3, '13, *3241*. Cataño, Nov. 6, '13, *4185*. Jajome Alto, Dec. 3, '13, *5756*.

Also collected by Heller, No. 141, Rio Piedras, and No. 6185 on the same host, Adjuntas; and on Willoughbaea. These all agree with Earle's cotype No. 6185. In some instances, especially in No. 5756, there is some variation in habit and the appendages are considerably larger than mentioned in the description.

17a. Meliola compositarum Earle var. portoricensis var. nov.

This form agrees with the type in perithecial characters but its mycelium is much more coarse, also its appendages are larger and more irregular.

On *Eupatorium portoricense* Urb. Fig. 16.

Vega Baja, Nov. 5, '13, *4301* (type). Dos Bocas, below Utuado, Dec. 30, '13, *6861, 6034, 6031, 6866, 6830, 6557*, Dec. 16, '13, *6003, 6032, 6031*, July 8, '15, *7953, 8102*. San Sebastian, Nov. 22, '13, *5192*. Vega Baja, July 2, '15, *7723*. Arecibo-Lares Road, June 20, '15, *7320*.

On *Eupatorium dolicholepis* Urb.

Rio Tanama, July 6, '15, *7893*.

On all hosts it is usually much overgrown with one or more parasites.

18. Meliola tuberculata sp. nov.

Colonies amphigenous, more common above, densely black, 1-3 mm. in diam., circular. Mycelium rather dense, quite crooked.

Capitate hyphopodia alternate, varying from simple and ovate to irregularly lobed, usually 30μ or more apart. Mucronate hyphopodia few, narrowly conic. Mycelial setae none. Perithecial setae none. Perithecial appendages conic, 51 x 27μ, very numerous, nearly every surface cell of the perithecium being prolonged into an appendage.

Perithecia 160μ in diam. Asci evanescent. Spores 4-septate, 38 x 14μ obtuse, slightly constricted.

On unknown dicotyledonous plant, Vega Baja, July 2, '15, No. *7742*, (type).

This species is clearly distinct from all other Porto Rican species studied, especially in the appendages to the perithecium, the crooked mycelium, and the variable hyphopodia.

19. Meliola calophylli sp. nov.

Colonies mainly epiphyllous, irregular, diffuse, 1-10 mm. in diam. Mycelium forming a loose network of threads which branch irregularly, 7μ in diameter.

Capitate hyphopodia alternate or irregular, not crowded, about 35μ apart, head cell ovoid or pyriform, often very angular and irregular, 24 x17μ, the basal cell 14μ long or less. Mucronate hyphopodia very irregular in arrangement, bottle-shaped, narrow, about 20μ long. Mycelial setae none. Perithecial setae very numerous, larvaeform, curved. Tip obtuse, 51 x 17μ, translucent.

Perithecia 220μ, ostiolar region thin. Asci soon evanescent; ascospores 4-septate, brown, very strongly constricted, obtuse, 44-47 x 17μ.

On *Calophyllum calaba* Jacq. Fig. 17.

Mayaguez, June 15, '15, *7059* (type). Mayaguez, June 25, '15, *7489*a. Vega Baja, Nov. 13, *4310*.

The species is remarkable for the very numerous larvaeform appendages, it appearing as though nearly every superficial cell of the perithecium develops into an appendage. The appendages are closely marked with transverse striae which simulate septa. The capitate hyphopodia are also characteristic. It resembles *M. inermis,* but distinguished from it by the smaller spores and more angular hyphopodia.

20. MELIOLA ARECIBENSIS sp. nov.

Colonies hypophyllous, irregular, 1-3 mm. in diam. Mycelium forming a rather close net work of threads which are slightly crooked and branch either opposite or alternate, about 6μ in diameter. Capitate hyphopodia alternate, one per cell, cells about 10-17μ long, head cell ovoid to cuneate or very irregular, 20 x 10μ, the basal cell varying from short to quite long, 20μ. Mucronate hyphopodia abundant, usually opposite, bottle-shaped, narrow, 20μ long. Mycelial setae none. Perithecial appendages larvaeform, few, 4-8, short, about 85μ, 20μ thick, curved to crooked, translucent, darker at tip. Perithecia 200μ, rough, with rounded protuberances, ostiole none. Asci soon evanescent; ascospores 4-septate, dark brown, very strongly constricted, obtuse, 44-51 x 20μ.

On*Acalypha bisetosa* Bert. Fig. 18.

Vega Baja, Feb. 21, '13, *365*a (type). Dos Bocas, below Utuado, Dec. 30, '13, *6547*.

This species collected only once is very striking. Possessing no setae either perithecial or mycelial and having the larvaeform chitinous appendages it falls within a class of but few members. It is also remarkable for the great variation in form and size of both kinds of hyphopodia, a variation far greater than I have seen on any other species. It is clearly seperated from *M. acalyphae* by its chitinous appendages and character of the hyphopodia.

21. MELIOLA MICONIEICOLA sp. nov.

Colonies hypophyllous, irregular, diffuse, 5-20 mm. in diam. Mycelium forming a very loose network of slightly wavy threads with branches mostly opposite, 6μ in diameter.

Capitate hyphopodia small, alternate or irregular, very distant, about 75μ apart, head cell ovoid or pyriform, sometimes slightly irregular, 17 x 14μ, the basal cell 4-10μ long. Mucronate hyphopodia few and scattered, mostly opposite, bottle-shaped, narrow, crooked, about 17μ long. Mycelial setae none. Perithecial setae few, about 3-10, arising from the base of the perithecium, straight or slightly curved. Tip obtuse, 30-85 x 7μ, dark. Perithecia 135μ, rough with rounded protuberances. Asci soon evanescent; ascospores 4-septate, brown, constricted, obtuse, 35-38 x 11μ.

On *Miconia sintenisii* Cogn. Fig. 19.

El Alto de la Bandera, July 15, '15, *8639* (type).

This Meliola is striking on account of its sparse mycelium with very distant hyphopodia.

22. Meliola tenuissima sp. nov.

Fungus amphigenous, more abundant above, colonies extremely thin, invisible to the naked eye, consisting of a loose network of wavy threads, 7μ in diameter. There is usually a distinct bend at each septum.

Capitate hyphopodia small, alternate, distant, head cell globular, ovoid or pyriform, not angular, 10μ in diam., the basal cell about 3μ long. Mucronate hyphopodia few, alternate or opposite, bottle-shaped, 20μ long. Mycelial setae none. Perithecial setae few, about 3-4, straight or bent, or even uncinate at tip, about 100μ long, 6μ thick. Tip obtuse, sometimes swollen.

Perithecia 170μ, slightly rough. Asci soon evanescent; ascospores 4-septate, brown, not constricted, obtuse, 34-37 x 14-15μ.

On *Gouania lupuloides* (L.) Urb.

Yauco, Oct. 3, '13, *3142* (type). Villa Alba, Jan. 3, '13, *96*.

This species is quite unique in the extreme sparseness of the mycelium.

23. Meliola parathesicola sp. nov.

Colonies hypophyllous, irregularly circular, punctiform, 1-2 mm. in diam. Mycelium brown, forming a very close mat, threads 8μ in diameter, branching irregularly.

Capitate hyphopodia alternate or irregular, very crowded, usually in contact with adjacent hyphopodia, head cell ovoid to nearly globular or slightly angular, 20 x 14μ, the basal cell 3-7μ long. Mucronate hyphopodia few and scattered, alternate or opposite, bottle-shaped, 20 x 7μ. Mycelial setae none. Perithecial setae few, 1-5, arising basally, straight, about 90 x 7μ, tip obtuse, dark throughout.

Perithecia 135-150μ, rough, with rather large conic projections. Asci soon evanescent, ascospores 4-septate, brown, cylindrical to elliptical, slightly constricted, obtuse, 48 x 20μ.

On *Parathesis serrulata* (Sw.) Mez. Fig. 20.

Las Marias, July 10, '15, *8192* (type), *8204*. Maricao, July 19, '15, *8947*, Sept. 20, '13, *3634*. Arecibo-Lares Road, June 21, '15, *7286*.

In colony and general characters it resembles *M. mayapaeicola,* but differs in setae and in shape of capitate hyphopodia.

24. Meliola toruloidea sp. nov.

Colonies amphigenous, more abundant below, circular, 1-4 mm. in diam. Mycelium black, forming rather close network of threads; branches opposite or alternate, 7μ in diameter, slightly wavy.

Capitate hyphopodia alternate, not crowded, one per cell, cells about 20μ long, head cell pyriform, 20 x 14μ, the basal cell very short, 5-6μ. Mucronate hypophodia opposite, bottle-shaped. Mycelial setae none. Perithecial setae few to many, often 30-40 per perithecium, distributed over its surface, strongly uncinate or spirally coiled, about 70μ long, 7-8μ thick, black. Young perithecia not radiate, 170μ, slightly rough, with rounded protuberances. Asci soon evanescent; ascospores 4-septate, light brown, constricted, obtuse, 34 x 16μ.

On *Cassia quinquadrangulata* L. Cl. Rich. Fig. 21.

Jajome Alto, July 17, '15, *8394* (type). Maricao, July 20, '15, *8980*, Jan. 10, '13, *206*. Aibonito, Nov. 5, '13, *4015*, July 16, '15, *8468*.

On *Inga laurina* (Sw.) Willd.

Las Marias, July 7, 10, '15, *8135*.

25. Meliola comocladiae sp. nov.

Colonies amphigenous, more abundant above, punctiform, 1-3 mm. in diam. Mycelium forming a network of threads; branches mostly opposite, 8μ in diameter.

Capitate hyphopodia alternate, not crowded, 17-20μ apart, head cell pyriform, angular and often bent, 20 x 14μ, the basal cell 3-5μ. Mucronate hyphopodia alternate or opposite, bottle-shaped. Mycelial setae none. Perithecial setae few or numerous, straight, usually with the tip uncinate or twisted, 115 x 8μ, dark throughout.

Perithecia 100-150μ, rough with conic protuberances, surrounded by an areola of radiating mycelial threads. Asci soon evanescent; 4-spored, ascospores 4-septate, pale brown, very slightly constricted, cylindrical, obtuse, 41 x 17μ.

On *Comocladia glabra* Spreng. Fig. 22.

Rosario, July 4, '15, *9015* (type). Mayaguez Mesa, June 25, '15, *7484*, June 15, '15, *7056*. Maricao, April 3, '13, *760*.

On *Spondias mombin* L.

Maricao, April 3, '13, *749*.

Perithecium and appendages quite similar to those of *M. tortuosa* but distinct from that species in mycelial characters.

The colonies are usually densely overgrown with parasites which make the characters difficult to determine. The absence of mycelial setae, the presence of the long perithecial setae, the characteristic radiation of mycelium from the base of the perithecium, and the characteristically angular capitate hyphopodia are each distinctive.

26. MELIOLA TORTUOSA Wint.

Gaillard, L'en Genre Meliola: 67, 1892.

On *Piper umbellatum* L. Fig. 23.

Utuado, Nov. 8, '13, *4414*, *4664*. Indiera Fria, Maricao, Oct. 8, '13, *3379*. Mayaguez, Oct. 31, '13, *3917*, Oct. 2, '13, *3152*. Lares, Nov. 22, '13, *4843*, *442*. Añasco, Oct. 12, '13, *3578*, *3507*, *3508*. Monte Alegrillo, Nov. '13, *4721*. El Gigante, near Adjuntas, July 16, '15, *8560*, *8497*. Florida Adentro, July 1, '15, *7669*, *7667*, *7686*. Jajome Alto, Dec. 3, '13, *5656*, *5692*. Dos Bocas, below Utuado, July 8, '15, *8055*, *8028*, *8063*. Las Marias, July 10, '15, *8146*. Rio Tanama, near Arecibo, July 6, '15, *7883*, *7909*, *7842*, *7916*, *7887*, *7848*. Arecibo-Lares Road, July 7, 15, *7956*, June 2, *7316*. Maricao, July 19, '15, *8843*. Rio Arecibo, July 8, '15, *7777*, *7792*.

On *Piper medium*, Jacq.

Vega Baja, July 2, '15, *7752*. A specimen determined by Earle is also in the Bronx collection.

On *Piper peltatum* L.

Heller, No. *6388*, Dec. 25, 1902, Ponce. The type was on leaves of Piper from Brazil. It has also been reported upon Dickensonia.

This form agrees with the descriptions except that the spores are a little too small, 37μ, while the description calls for 49-54μ. It is almost always present where the host is found, often covering the leaves with its black coating.

27. MELIOLA CHAMAECRISTICOLA sp. nov.

Colonies epiphyllous, circular, 1-2 mm. in diam. Mycelium black, forming a rather close network, 7μ in diameter.

Capitate hyphopodia small, alternate, not crowded, 1 per cell, cells about 14 to 17μ long, head cell ovoid, 14 x 10μ, the basal cell 3μ long. Mucronate hyphopodia alternate or opposite, bottle-shaped, 14-16 x 6μ. Mycelial setae none. Perithecial setae few, straight or slightly curved, 80 x 4μ. Tip obtuse, dark throughout.

Perithecia 170μ, slightly rough with rounded protuberances. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 34 x 14μ.

On *Chamaecrista granulata* (Urb.) Britt. Fig. 24.

Mona Island, Dec. 20, '13, *6113* (type).

This differs from all other forms in this section in the extremely thin setae.

28. MELIOLA RECTANGULARIS sp. nov.

Colonies epiphyllous, circular to irregular, 1-10 mm. in diam. Mycelium forming a loose network of threads with opposite branches which usually form right angles at the point of origin, 7μ in diameter.

Capitate hyphopodia alternate, about 25μ apart, cylindrical to ovoid, head cell 17 x 10μ, scarcely thicker than the stalk cell, the basal cell 3-5μ. Mucronate hyphopodia alternate or opposite, conical to narrowly bottle-shaped, the neck narrow, 20 x 6μ. Mycelial setae none. Perithecial setae few, short, 80μ or less, opaque, straight or slightly curved. Tip obtuse.

Perithecia 170μ. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 38 x 14μ.

On *Coccolobis laurifolia,* Jacq. Fig. 25.

Arecibo-Lares Road, June 21, '15, *7292* (type).

This species is chiefly characterized by its poorly differentiated hyphopodia and the right-angled branching. In the first of these characters it approaches *M. magnoliae* but is quite distinct from that form.

On *Banisteria laurifolia* L.

Jayuya, March 3, '13, *1001.* Maricao, Sept. 20, '13, *4852.* Utuado, Nov. 8, '13, *4392*a, *4384.* Hormigueros, K. 7, June 23, '15, *7358.* Mayaguez Mesa, June 29, '15, *7564.* Martin Peña, Oct. 11, '15, *9298.*

29. MELIOLA CHIOCOCCAE, sp. nov.

Colonies epiphyllous, irregular, circular, 1-5 mm. in diam. Mycelium black, forming a loose network, 7μ in diameter, branches mostly opposite and at right angles.

Capitate hyphopodia alternate, not crowded, 1 per cell, cells about 20μ long, head cell irregularly globular, angular, 17μ in diameter, the basal cell 2-6μ long. Mucronate hyphopodia not seen. Mycelial setae none. Perithecial setae few, straight or slightly curved, 120 x 7μ. Tip obtuse, dark throughout.

Perithecia 170μ, slightly rough. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 37-41 x 14μ.

On *Chiococca alba* (L.) Hitch. Fig. 26.

Vega Baja, July 2, '15, *7743* (type). Hormigueros, June 23, '15, *7325.*

30. MELIOLA PTERIDICOLA sp. nov.

Colonies amphigenous, mainly epipyllous, 1-6 mm. in diam. Mycelium forming a loose network of threads which show a marked tendency to be rectilinear and to branch at right angles, quite dark, septation obscure.

Capitate hyphopodia alternate or irregular, not crowded, about 30μ apart, ovoid or pyriform, 17 x 3μ, apex thickened, the basal cell very short. Mucronate hyphopodia few and scattered or abundant on certain threads, alternate or opposite, small, bottle-shaped, the neck narrow, 16-18μ long x 7μ wide. Mycelial setae none. Perithecial setae few, about 3-10, 90 x 7μ, dark, straight, or slightly curved at tip. Tip obtuse.

Perithecia 170μ, rough, with rounded protuberances of small, 6-10μ, subprominent cells, ostiole none. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 35-40 x 4μ.

On *Aneimia adiantifolia* (L.) Sw. Fig. 27.

Rio Tanama, near Arecibo, July 6, *7814* (type). Quebradillas, June 23, *7269.* Dos Bocas, below Utuado, July 8, *8015.*

On *Aneimia* sp. Dos Bocas, below Utuado, Dec. 30, '13, *6594.*

On *Adiantum latifolium* Lam.

Las Marias, July 10, *8182.* Mayaguez, June 24, *7418.*

On *Adiantum* sp. aff. *A. cristatum.*

Mayaguez 3, July 19, *8795.*

On *Adiantum sp.*

Mayaguez, May 1, '13, *1063.*

This species is very abundant, forming dense dark patches upon the leaves and petioles though no signs of injury to the host are evident. The fungus falls within the group characterized by perithecial setae, but no mycelial setae, a group with but few representatives, none of which can be confounded with this. The chief, distinctive character is the parallel coursing of the mycelium. The colonies are usually densely parasitized by Helminthosporium, Podosporium, or Asterina, each giving its characteristic effect to the colony. The occurrence of both Helminthosporium and Podosporium upon this Meliola presents a strong argument as to the parasitic nature of these forms rather than their being a stage in the development of the Meliola itself.

31. Meliola molleriana Wint.

Hedw. 25: 98, 1886.

On *Sida urens* L.

Aguada, Nov. 22, '13, *5090.* Mayaguez, March 9, '13, *483.* San German, Dec. 8, '13, *4114*, June 27, '15, *7508.* Añasco, Oct. 12, '13, *3530.* Yauco, Oct. 3, '13, *3243.* Cataño, Nov. 6, '13, *4184.* St. Ana, Dec. 31, '13, *6693.* Arecibo-Lares Road, June 21, '15, *7310*, *7239.* Dos Bocas, below Utuado, July 8, '15, *8031*, *8079.* Las Marias, July 10, '15, *8209.* Rosario, Aug. 4, '15, *9498*, *9486.* El Miradero, Aug. 4, '15, *9151.*

These specimens have somewhat shorter and thinner perithecial appendages and smaller spores than the description calls for. The fungus is very common, almost always present where the host grows.

On *Varronia* sp.

Las Marias, July 10, '15, *8139.* El Miradero, Aug. 3, '15, *9133*, Aug. 4, '15, *9164.* Mayaguez, June 24, '15, *7412.* El Alto de la Bandera, July 14, '15, *8593.*

32. Meliola cupaniae sp. nov.

Colonies epiphyllous, irregular, 2-10 mm. in diam., confluent, diffuse. Mycelium forming a very loose network of threads, branches mostly opposite, 7μ in diameter.

Capitate hyphopodia alternate, distant, 37-70μ apart, head cell ovate to cuneate, smooth or angled, often truncate, the basal cell 7μ long. Mucronate hyphopodia opposite, bottle-shaped to conic, about 20μ long. Mycelial setae none. Perithecial setae 3-12, straight or curved. Tip obtuse, 140 x 5μ, dark.

Perithecia 110-170μ, rough, with rounded protuberances. Asci soon evanescent; ascospores 4-septate, brown, cylindrical, slightly constricted, obtuse, 37 x 14μ.

On *Cupania americana* L. Fig. 28.

El Miradero, near Mayaguez, Aug. 4, '15, *9143* (type), *9489*, Aug. 11, '15, *9318.* Maricao, July 19, '15, *8948.* Dos Bocas, near Utuado, July 8, '15, *8080.* Quebradillas, Nov. 22, '13, *4979.*

On *Cupania* sp. Quebradillas *4779.*

The distinctive character of this species is the sparse mycelium and distant hyphopodia which are long and narrow.

33. Meliola ocoteae sp. nov.

Colonies hypophyllous, irregular, 5-10 mm. in diam. Mycelium very dark, 6μ thick, crooked, loose, branches opposite or alternate.

Capitate hyphopodia alternate or unilateral, about 50-80μ apart, head cell ovoid or angular, 20 x 14μ, stalk cell 10 x 14μ long. Mucronate hyphopodia scant, bottle-shaped. Mycelial setae none. Perithecial setae numerous, 20μ, straight or slightly curved, rigid, dark, about 85μ long, apex obtuse.

Perithecia 170μ, black. Asci evanescent. Spores 4-septate, dark, constricted, somewhat pointed at ends, 50 x 14μ.

On *Ocotea leucoxylon* (Sw.) Mez.

Jajome Alto, July 17, '15, *8428* (type).

Resembling *M. molleriana* but differing from it in number, length and character of the perithecial hairs and in mycelial characters. Usually densely overgrown with conidial forms.

34. MELIOLA COMPACTA Earle

Bull. N. Y. Bot. Gard. 3: 306, 1905. Collected by Heller, No. 6217, "on *Crossopetalum pallens.*"

35. MELIOLA MICONIAE sp. nov.

Colonies epiphyllous, circular, 2-5 mm. in diam., very sharply limited, black, smooth. Mycelium forming a close network of threads mainly with opposite branches, 7μ in diameter.

Capitate hyphopodia alternate or irregular, not crowded, about 30μ apart, head cell pyriform, irregular and angular, often bent, the basal cell 7-9μ long. Mucronate hyphopodia not seen. Mycelial setae none. Perithecial setae very inconspicuous, few, about 3-10, straight or slightly curved, or coiled, 30-85 x 10μ. Tip obtuse.

Perithecia 170-225μ, slightly rough with conic protuberances. Asci four-spored, soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 44-47 x 17μ.

On *Miconia prasina* (Sw.) P. DC. Fig. 29.

Las Piedras, Aug. 12, '15, *9366* (type). Las Marias, July 10, '15, *8160*.

This species is quite distinct from the two others found in Porto Rico upon Melastomataceae. Its very distinct colony is readily recognizable by the naked eye as a distinct form.

36. MELIOLA TRIUMFETTAE sp. nov.

Colonies epiphyllous, punctiform, 1-3 mm. in diam. Mycelium forming a close network of crooked threads which branch irregularly, 6μ in diameter.

Capitate hyphopodia small, alternate or irregular, not crowded, about 17-50μ apart, head cell globular to pyriform, 14μ in diam., the basal cell short. Mucronate hyphopodia few and scattered, alternate or opposite, bottle-shaped, about 20 x 7μ. Mycelial setae none. Perithecial setae few, about 1-5, somewhat crooked, 70-85 x 6μ, yellow, translucent. Tip obtuse.

Perithecia irregularly globular, 85-140μ in diam., very rough, with conic protuberances, translucent. Asci soon evanescent; ascospores 4-septate, brown, constricted, obtuse, 34-41 x 10-14μ.

On *Triumfetta semitriloba* Jacq.

Utuado, Nov. 8, '15, *4421* (type). Indiera Fria, Oct. 8, '13, *3482.*

On *Hibiscus tiliaceus* L.

Arecibo-Lares Road, June 21, '15, *7249.* Maricao, July 20, '15, *8962.* Dos Bocas, below Utuado, July 8, '15, *8073.*

The specimens on Hibiscus while they show the same characteristic perithecia and hyphopodia, are somewhat differentiated as to the habit of the mycelium, which is less crooked and produces larger colonies than on Triumfetta. Perithecial setae are also decidedly more variable in number, sometimes entirely lacking, at other times numerous.

37. MELIOLA MARICAENSIS sp. nov.

Colonies hypophyllous, irregular, sparse, 5-15 mm. in diam., confluent. Mycelium forming a very loose network of black threads 7μ in diameter, branching irregular.

Capitate hyphopodia alternate or irregular, distant, about 30-70μ apart, head cell ovoid to pyriform and regular, or subpyriform, angular and quite irregular, 17 x 10μ, the basal cell 5-7μ long. Mucronate hyphopodia alternate or opposite, bottle-shaped, 16-18 x 7μ. Mycelial setae none. Perithecial setae few, about 3-10, straight or slightly curved at tip, 100-150 x 7μ, dark. Tip obtuse.

Perithecia 170μ, rough, with rounded protuberances. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 48 x 20μ.

On *Ilex nitida* (Vahl) Maxim.

Maricao, Oct. 20, '13, *3679* (type), *3607*, April 4, '13, *824.*

Close to *M. cupaniae* but separable from it by the shape of the capitate hyphopodia.

SECTION D

Spores 4-septate, mycelial and perithecial setae present.

Key to Species of Section D.

Setae broadly uncinate	M. contorta No. 38
Setae not broadly uncinate	
Spores long and narrow, 48-51 x 7-9μ	M. mayaguesianaNo. 39
Spores not long and narrow	
Spores apiculate	M. circinans No. 40
Spores not apiculate	M. cyperi No. 41

38. Meliola contorta sp. nov.

Colonies amphigenous, mainly below, irregularly circular, 1-6 mm. in diam., black. Mycelium forming a moderately loose network of threads with branches usually opposite, 7μ in diameter.

Capitate hyphopodia large, alternate, abundant but not crowded, one to each cell and cells about 35μ long, ovoid or elliptical, head cell 17-10μ, apex obtuse, the basal cell about 7μ long. Mucronate hyphopodia opposite, alternate or scattered, bottle-shaped, the neck narrow. Mycelial setae few, scattered, similar to the perithecial in character. Perithecial setae variously curved or uncinate at the tip, several from the base of each perithecium. About 150μ long, 10μ thick; apex variously marked, slightly tapering, with numerous, sharp, lateral projections, or uncinate with roughenings, or short bifid with the branches cut into small, sharp teeth.

Perithecia 140μ, slightly rough, with rounded protuberances, ostiole none. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 34-37 x 10μ.

On *Piper hispidum* Sw. Fig. 30.

Las Marias, July 11, '15, *8225* (type).

This species which is my only collection of Meliola upon the host is very interesting. It belongs in that section of the genus in which few species are found, characterized by both mycelial and perithecial setae. The setae moreover, are unique in being both uncinate and forked and toothed.

39. Meliola mayaguesiana sp. nov.

Colonies amphigenous, mostly hypophyllous, circular, 2-8 mm. in diam. Mycelium black, forming a rather close network, 7μ in diameter, branches irregular, quite crooked, tangled.

Capitate hyphopodia small, alternate, not crowded, 1 per cell, cells about 40μ long, head cell ovoid or truncate, apex often thickened, 17 x 10μ, the basal cell varying from very short to 7μ long. Mucronate hyphopodia few and scattered, narrow, alternate, bottle-shaped, 27 x 7μ. Perithecial setae few, about 3-10, about 100μ long, 7μ thick, black throughout, contorted, usually spirally twisted, sometimes coiled into close knots; tips obtuse. Mycelial setae abundant, straight or slightly curved, very long, about 800μ, 9μ thick dark throughout, simple.

Perithecia 150μ, rough with conic protuberances. Asci 2-4-spored; ascospores 4-septate, pale brown, very long and narrow, slightly constricted, obtuse, 48-51 x 7-9μ.

On *Palicourea crocea* (Sw.) Roem. Fig. 31.

Lajas, June 17, '15, *7157* (type), June 17, '15, *7196*. Las Marias, July 10, '15, *8138, 8162*.

On *Palicourea domingensis* (Jacq.) DC.

Piedras, Aug. 12, '15, *9320*.

On *Palicourea riparia,* Benth.

Mayaguez, June 25, '15, *7403, 7019*.

On *Palicourea* sp.

Mayaguez, Apr. 30, '13, *979*. May 3, '13, *1131*.

This Meliola is remarkable in several ways. Possessing both perithecial and mycelial setae it falls within a class of very few representatives indeed. The ascospores too, are distinctly unique, being much more slender than those of any other Meliola that I have seen.

40. Meliola circinans Earle

Bull. N. Y. Bot. Gard. 3: 308, 1905.

On *Mariscus jamaicensis* (Crantz) Britton.

San Juan, Aug. 15, '15, *9221*, Aug. 9, '15, *9203*. Manati, Nov. 25, '15, *5286*.

The type collection was made by Heller, No. 6384, on *Rynchospora aurea*.

Our specimens clearly agree with the type of Earle especially in the possession of both perithecial and mycelial setae of different lengths. The capitate hyphopodia are quite variable and though the circinate forms do occur I would not attach so much importance to this character as Earle seems to do. The sub-apiculate ascospores, however, are quite distinctive and the thickness of the mycelium and of the setae clearly separates this species from *M. cyperi*.

41. MELIOLA CYPERI Pat.

Gaillard, Le Genre Meliola: 70, 1892.

On *Cyperus* sp.
Mayaguez, Oct. 31, '13, *3946*.
On *Scleria*.
Manati, Nov. 25, '13, *5252*, *5286*.
On *Mariscus jamaicensis* (Crantz) Britton.
San Juan, Aug. 15, '15, *9221*.

This species and *M. circinans* are remarkable in that they have both mycelial and perithecial setae and one is loath to admit that two distinct species showing this very unique character are to be found in Porto Rico, especially upon the same host, and more especially upon the same plant, No. 9221. Still, a study of these two forms bears in the conviction that they are actually distinct, one with apiculate spores, the other obtuse, one with cylindrical, narrow, capitate, hyphopodia, the other with thick angular ones, one with thick setae and mycelium, the other thin.

SECTION E

Spores, 4-septate, mycelial setae simple. No perithecial appendages.

KEY TO SPECIES OF SECTION E

Spores acute	M. psidii No. 42
Spores not acute	
Setal tips swollen	M. clavulata No. 43
Setal tips not swollen	
Tips often uncinate	M. nigra No. 44
Tips not often uncinate	
Capitate hyphopodia opposite	
Head cell conic	M. praetervisa No. 45
Head cell rounded	M. andirae No. 46
Capitate hyphopodia in part opposite, in part alternate	
Opposite hyphopodia numerous	
Head cell very irregular	M. monensis No. 47
Head cell not very irregular	
Setae 400μ	M. thouiniae No. 48
Setae 600μ	M. didymopanicis No.49
Setae 900μ	M. amomicola No. 50

Opposite hyphopodia comparatively few	
Setae 1100μ long	M. myrsinacearum No. 51
Setae 600-700μ long	M. pilocarpi No. 52
Capitate hyphopodia alternate	
Many of the head cells very irregular or angular	
Mycelium very crooked	
Setae sparse	M. stenotaphri No. 53
Setae abundant	M. capsicola No. 54
Mycelium not very crooked	
Capitate hyphopodia very distant, 700-100μ	M. paucipes No. 55
Capitate hyphopodia less distant	
Setae obtuse	M. panici No. 56
Setae acute	
Setae brown	M. rudolphiae No. 57
Setae black	M. serjaniae No. 58
Head cells not strongly angular	
Setal tips acute	
Mycelium quite straight	
Setae not broadly curved	
Capitate hyphopodia ovate	M. dipholidis No. 59
Capitate hyphopodia cylindrical	M. ocoteicola No. 60
Setae broadly curved	M. paulliniae No. 61
Mycelium more or less crooked	
Mycelium decidedly crooked	
Setae 250μ	M. chamaecristae No. 62
Setae 150μ	M. earlii No. 63
Mycelium slightly crooked	
Head cells ovate to globular	M. gesneriae No. 64
Head cells elliptical	M. jatrophae No. 65
Setae tips obtuse	
Head cell short, nearly globular	
Capitate hyphopodia 20μ apart	M. mayepeae No. 66
Capitate hyphopodia 35μ apart	M. gymnanthicola No. 67

Head cell cylindrical or only very slightly thickened	
Mycelium and hyphopodia not irregular	M. lucumae No. 68
Mycelium and hyphopodia irregular	M. amiphitricha No. 69
Head cell ovate or elliptical	
Setae very long, 1000μ	M. byrsonimae No. 70
Setae not so long	
Setae very numerous	M. tabernaemontana No. 71
Setae less numerous	
Tips dark	
Setae straight	M. ambigua No. 72
Setae curved	M. paulliniae No. 61
Tips pale	
Head cell elliptical	M. psychotriae No. 73
Head cell broader	
Spores small, 35μ	M. mayepeicola No. 74
Spores large, 60μ	M. clusiae No. 75

M. guareae found under section G., if the rare forked setae be overlooked, might be sought in this section.

The species of this section offer, perhaps, the greatest difficulty of classification of all of the Meliolas because of the very large number of forms which fall within the section and the few characters involved. Chief dependence for specific characterization must be placed upon the setae, mycelium, and hyphopodia, since differences are often wanting in other characters.

42. MELIOLA PSIDII Fr.

Linnaea 5: 549, 1830.

On *Psidium guajava* L.

Yauco, Oct. 3, '13, *3120*. San German, Dec. 12, '13, *5841*. Mayaguez, Oct. 31, '13, *3899*, March 9, '13, *493*, *6443*. San Sebastian, Nov. 22, '13, *5202*. Vega Alta, Nov. 13, *4183*. Jajome Alto, Dec. 3, '13, *5642*a, July 17, '15, *8377*. Arecibo-Lares Road, June 21, '15,*7302*. Dos Bocas, below Utuado, July 8, '15, *8033*. Vega Baja, July 2, '15, *7721*. Sabana Llana, Aug. 13, '15, *9377*. Maricao, July 20, '15, *8860*. Utuado, *6563*. Jayuya, *3120*a.

Collected by Heller, No. 4360, near Mayaguez.

The shape of the ascospores is the chief distinguishing character of this species. The form is very common on the guava wherever it grows.

43. Meliola clavulata, Wint.

Hedw. 25: 98, 1886.

On *Ipomoea* sps.

Sabana Llana, Aug. 13, '15, *9368*. Monacillo, Aug. 12, '15, *9342*. Rio Piedras, Nov. 3, '13, *5700*. Trujillo Alto, Aug. 15, '15, *9419*. El Miradero, Aug. 4, '15, *9169*. Vega Alta, Nov. 1, '13, *4088*.

On *Ipomoea cathartica* Poir. Fig. 32.

Rio Arecibo, K. 64.7, July 8, '15, *7837*.

The folowing collections appear to belong to the same species but in every instance the terminal setal cell was broken off.

On *Ipomoea cathartica* Poir.

El Alto de la Bandera, July 15, '15, *8655*, July 16, '15, *8692*. Rio Arecibo, K. 64.5, July 8, '15, *7782*. Vega Baja, July 2, '15, *7729*.

On *Ipomoea batatas* (L.) Lam.

Vega Alta, Nov. 1, '13, *5725*. Rio Tanama, July 7, '15, *7927*, *7926*. Maricao, July 20, '15, *8954*.

On *Ipomoea tiliacea* (W.) Choisy.

Mayaguez, No. *46*.

On *Ipomoea* sps.

Trujillo Alto, Aug. 15, '15, *9432*. Rio Piedras, Aug. 11, '15, *9466*, Aug. 10, '15, *9196*. Mayaguez, Aug. 12, '15, *8098*. San German, Dec. 12, '13, *5850*.

The species was originally described from St. Thomas, Africa, but the Porto Rican specimens agree remarkably with Winter's description, and with a "cotype" specimen (E. Ule, Rio de Janeiro, Brazil 7, 1887), kindly sent to me by H. Sydow.

44. Meliola nigra sp. nov.

Colonies very black, velvety with setae, amphigenous, more abundant above, circular, 1-10 mm. in diam. Mycelium forming a close network of threads, branches mostly opposite and at nearly right angles, 7μ in diameter.

Capitate hyphopodia alternate, not crowded, about 17μ apart, head cell obovoid or pyriform or angular, 14 x 10μ, basal cell short. Mucronate hyphopodia opposite, bottle-shaped, 17μ long. Perithecial setae none. Mycelial setae many, forming a dense covering to the whole of the colony except its extreme edge. About 200-270μ long, 7-9μ thick, dark throughout, curved, often recurved at tip. Tip obtuse.

Perithecia 150-160μ, slightly rough with rounded protuberances. Asci 2-spored; ascospores 4-septate, brown, very slightly constricted, obtuse, 37-41 x 14-17μ.

On *Laguncularia racemosa* (L.) Gaertn.

Guanajibo, June 19, '15, *7197* (type). Joyuda, May 31, '15, *363.*

45. MELIOLA PRAETERVISA Gaill.

Gaillard, Le Genre Meliola: 78, 1892.

On *Coccolobis pyrifolia* Desf. Fig. 33.

Mayaguez, June 15, '15, *7065*, Feb. 9, *1900*, collected by Heller. Jajome Alto, Dec. 3, '13, *5653*a.

On *Coccolobis sintenisii,* Urb.

Mayaguez, June 15, '15, *7066.*

On *Coccolobis sp.*

Jajome Alto, July 7, '15, 17, *8386.*

On *Cupania americana* L.

Mayaguez, June 23, '15, *7372.*

The form on Cupania has the setae occasionally forked and the capitate hyphopodia are conical rather than cylindrical. This species is quite remarkable for its crowded opposite hyphopodia. These hyphopodia, moreover, are set at very uniform angles owing to the fact that the inner side of the stalk cell is uniformly shorter than the outer side. The specimens on No. 8386 have setae somewhat longer than on other hosts and no forked ones were observed.

46. MELIOLA ANDIRAE Earle

Bull. N. Y. Bot. Gard. 3: 303, 1905.

On *Andira jamaicensis* (W. Wr.) Urb. Fig. 34.

Rio Arecibo K, 64.7, July 8, '15, *7800.* Martin Peña, Aug. 11, '15, *9294.* Yauco, Oct. 3, '13, *3132, 3247*, *3137.* St. Ana, Dec. 31, '13, *6613.* Maricao, Jan. 10, '13, *204*, Apr. 3, '13, *766.* Dos Bocas, below Utuado, Dec. 30, '13, *6566.* Vega Alta, Nov. 13, '13, *4180.* Mayaguez, May 1, '13, *1078.* Lares, Nov. 22, '13, *4917.* Maricao, July 19, '15, *8901.* Manati, Nov. 25, '13, *5629*, Aug. 1915, *9481.* This species conforms fully with Heller's type specimen No. *6448*, collected at Santurce, Jan. 22, 1903, and is one of the best marked of all the Meliolas.

47. MELIOLA MONENSIS sp. nov.

Colonies mainly epiphyllous, black, small, 1-2 mm. in diam., punctiform. Mycelium forming a very close network of threads; branches crowded, 7μ in diameter.

Capitate hyphopodia alternate or opposite, crowded, mycelial cells about 20μ long, head cell very irregularly lobed, about 17 x 17μ, the basal cell about 7μ long. Mucronate hyphopodia few, scattered, alternate or opposite, bottle-shaped, the neck narrow, often crooked, 20μ long. Perithecial setae none. Mycelial setae abundant, straight, rigid, black, simple, about 400μ long, 10-14μ thick. Tip obtuse.

Perithecia 250μ, slightly rough with rounded protuberances. Asci 78 x 38μ, soon evanescent; ascospores 4-septate, pale brown, slightly constricted, obtuse, 45-52 x 20-22μ.

On *Amyris elemifera* L. Fig. 35.

Mona Island, Dec. 20-21, '13, *6158* (type), *6150*, *6146*. Guayanilla, July 14, '15, *8547*.

The colonies of this species are characteristic and the capitate hyphopodia distinctive.

48. Meliola thouiniae Earle

Bull. N. Y. Bot. Gard. 3: 308, 1905.

On *Allophylus crassinervis* Rad.

Quebradillas, Aug. 5, '15, *9003*.

On *Thouinia striata* Rad. Fig. 36.

Vega Baja, July 2, '15, *7756*. Rio Arecibo, K. 64.7, July 8, '15, *7773*.

The type was collected on the same host by Heller near Bayamon, Jan. 21, 1903, No. *6435*.

The cylindrical, capitate hypophodia, so crowded as to touch each other, give a unique appearance to the colonies on Allophyllus. Study of the type specimen and my own specimens on Thouinia shows variation in the crowding of the hyphopodia. In some parts of the colony they are densely crowded and opposite; at the edge of the same colony they may be strictly alternate and sparse.

On *Winterana canella* L.

Guayanilla, July 14, '15, *8548*, July 26, '15, *9075*. Mona Island, Dec. 20, '13, *6154*. Ponce, Aug. 7, '15, *9189*.

On *Krugiodendron ferreum* (Vahl) Urb.

Guayauilla, July 14, '15, *8594*. Rio Tanama, near Arecibo, July 6, '15, *7895*. Quebradillas, Aug. 10, '15, *9247*, June 20, '15, *9266*. Coamo, Feb. 6, '13, *814*, Apr. 6, '13, *831*.

49. Meliola didymopanicis P. Henn.

Hedw. 34: 106, 1895.

On *Dendropanax arboreum* (L.) Dec. & Pl.

Rio Arecibo, K. 64.7, July 8, '15, *7775*, Mayaguez Mesa, June 25, '15, *7440*. Florida Adentro, July 1, '15, *7647*.

On *Dendropanax laurifolium* (E. March.) R. C. Schneider.

El Alto de la Bandera, July 14, '15, *8265*.

The species was described from Brazilian specimens on *Didymopanax* sps. My material does not agree exactly with the somewhat meagre description, but does agree fully with a co-type specimen (Glazion, Minas Geraes, Brazil 1893) kindly furnished by Dr. H. Sydow. No perithecial setae are evident, though the mycelial setae are often clustered around the base of the perithecium, which may account for this character in the description. A striking character in my specimens is the capitate hyphopodia, which are usually opposite, with a regular, oval head cell. The chief distinction between this species and *M. araliae* seems to be in the length of the setae. It is possible that *M. didymopanicis* should be reported under that name. *M. araliae* was collected in Porto Rico, by Ule, No. 242 in 1884 on "*Aralia arborea*".

50. MELIOLA AMOMICOLA sp. nov.

Colonies mostly hypophyllous, black, circular to irregular, diffuse, 5-15 mm. in diam. Mycelium rather closely woven, nearly straight, black to pale straw color, branches mostly opposite, 6μ thick.

Capitate hyphopodia mostly opposite, two per cell, cells about 24μ long. Head cell cylindrical, straight or crooked, little or no thicker than the stalk cell, stalk cell 2-4μ long. Mucronate hyphopodia scattered, bottle-shaped, 24 x 6μ. Perithecial setae none. Mycelial setae sparse, scattered, long, 900-1000μ, 10μ thick at base, black throughout, acute.

Perithecia scattered, 180μ in diam. Spores 15 x 17μ, strongly constricted, obtuse.

On *Amomis caryophyllata* (Jacq.) Krug. and Urb. Fig. 37.

Mayaguez Mesa, June 15, '15, *7054* (type). Mayaguez, June 25, '15, *7483*.

51. MELIOLA MYRSINACEARUM sp. nov.

Colonies amphigenous, more abundant above, irregular, circular, 1-10 mm. in diam., confluent. Mycelium black, forming a close network, 10μ in diam., branches mostly opposite.

Capitate hyphopodia alternate, unilateral or irregular, not crowded, 1 per cell, cells about 34μ long, head cell nearly cylindrical or slightly pyriform, 20 x 14μ, the basal cell 2-4μ long. Mucronate hyphopodia few and scattered, alternate or opposite, bottle-shaped, 24 x 10μ. Perithecial setae none. Mycelial setae few or absent in young colonies, abundant in old colonies, straight or slightly curved, 625+ x 10μ, dark throughout, tip obtuse.

Perithecia 200μ, somewhat rough. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 51 x 17-20μ.

On *Ardisia guadalupensis* Duc.

Mayaguez Mesa, June 29, '15, *7576* (type), *7057*.

On *Myrsinaceae* indet.

Maricao, July 19, '15, *8905*, Oct. 20, '13, *3681*.

This species is closely related to *M. amphitricha* but distinguished from it by the shape of the capitate hyphopodia.

52. Meliola pilocarpi sp. nov.

Colonies hypophyllous, irregular, 4-15 mm. in diam., black. Mycelium forming a loose network of threads, branches opposite or alternate, 8μ in diameter.

Capitate hyphopodia alternate, rarely opposite, not crowded, one per cell, cells, 20-30μ long, head cell cylindrical or slightly thickened, 20 x 10μ, the basal cell short. Mucronate hyphopodia mostly opposite, bottle-shaped, the neck often curved, 20 x 7μ. Perithecial setae none. Mycelial setae few, scattered, straight, black, 1100μ long, 10μ thick at base, tip acute.

Perithecia 190μ in diam. Asci soon evanescent; ascospores 4-septate, brown, strongly constricted, obtuse, 51-54 x 17-20μ.

On *Pilocarpus racemosus* Vahl.

Mayaguez, June 13, '15, *7080* (type).

53. Meliola stenotaphri sp. nov.

Mycelium crooked or in zig-zag bends about equal in number to the hyphopodia.

Capitate hyphopodia alternate, or for considerable distances unilateral, with distinct stalk of much smaller diameter than the head. Stalk cell 7μ wide, 5-9μ long; head cell spherical or oval, about 20 x 14μ. Mucronate hyphopodia scarce, opposite or alternate, ampulliform, 7 x 14μ. Mycelial setae dark, opaque, about 275μ long, 7μ thick at base, simple and acute or very rarely bifid. Perithecial setae none.

Perithecia small, about 100μ, surface rough with rounded protuberances. Spores oblong, 4-septate, obtuse, slightly constricted, 30-44 x 10-14μ.

On *Stenotaphrum secundatum* (Walt.) Ktze. Fig. 38.

Manati, Nov. 5, '13, *4304* (type). Rio Tanama, near Arecibo, July 7, '15, *7940* July 7, '15, *7852*. ' Dos Bocas, below Utuado, July 8, '15, *8023*. Arecibo, K. 64.7, July 8, '15, *7810*.

The mycelium is distinctive, rather closely woven and with numerous crooks or zig-zags. The long stalks and rounded heads of the capitate hyphopodia are also sufficient to separate this from other forms.

54. Meliola capsicola sp. nov.

Colonies amphigenous, foliicolous and caulicolous, circular, 1-3 mm.

in diam., black. Mycelium forming a very close network, 7μ in diameter, branches irregular, crooked.

Capitate hyphopodia alternate, not crowded, 1 per cell, cells about 20 to 30μ long, head cell very irregular in shape and size, the basal cell often long. Mucronate hyphopodia few and scattered, bottle-shaped, irregular, 20 x 7μ. Perithecial setae none. Mycelial setae abundant, straight or slightly curved, 265 x 10μ, dark throughout, tip acute.

Perithecia 170μ, slightly rough. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 41 x 14μ.

On *Capsicum baccatum* L. Fig. 39.

Manati, July 2, '15, *7698*. Dos Bocas, below Utuado, July 8, '15, *8019* (type).

On account of the great variation in the hyphopodia, both in shape and size, the form is noteworthy.

55. Meliola paucipes sp. nov.

Colonies amphigenous, mainly below, irregular, scattered, diffuse, 5-10 mm. in diam. Mycelium forming a very loose network of threads, branching irregularly, 7μ in diam.

Capitate hyphopodia alternate or irregular, distant, 70-100μ apart, ovoid or pyriform, often angular, head cell 17 x 14μ, the basal cell about 4μ long. Mucronate hyphopodia mostly alternate, bottle-shaped. Mycelial setae none. Perithecial setae scattered, very long, 700 x 10μ, straight, simple, tip obtuse.

Perithecia 160μ, slightly rough, ostiole none. Asci evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 37 x 14μ.

On *Piper blattarum*, Spreng. Fig. 40.

Mayaguez Mesa, June 25, '15, *7463* (type).

This species, the only collection upon the host, is distinguished from others by its very long mycelial setae on a loose mycelium, with distant hyphopodia.

56. Meliola panici Earle

Muhlenbergia 1: 12, 1901.

On *Panicum glutinosum* Sw.

Maricao, Nov. 18, '13, *4801*, July 19, '15, *8934*, July 20, '15, *8957*. Monte de Oro, near Cayey, Dec. 3, '13, *5560*, *5744*, *5672*, *5746*. Utuado, Nov. 8, '13, *4389*. El Alto de la Bandera, Nov. 8, '13, *4368*, July 16, '15, *8930*, *8680*, *8647*. Ponce, Nov. 8, '13, *4375*. El Gigante, Dec. 15, '13, *5947*. Las Marias, July 10, '15, *8187*.

On *Paspalum schreberianum* (Fl.) Nash.

Maricao, July 19, '15, *8803*.

On *Lasiacis compacta* (Sw.) Hitch.

Utuado, Nov. 8, '13, *4643*, *4663*.

On *Lasiacis divaricata* (L.) Hitch.

Arecibo, Jan. 17, '14, *6810*. Manati, Nov. 5, '13, *4298*. Vega Alta, Nov. 5, '13, *4195*, *4189*. Vega Baja, Nov. 5, '13, *4237*. Nov. 22, Arecibo, by Mrs. A. Chase.

On *Lasiacis swartziana,* Hitch.

Añasco, Oct. 12, '13, *3561*. Las Marias, July 10, '15, *8191*.

On *Oplismenus setarius* (Lam.) Roem. & Schult.

Maricao, July 19, '15, *8776*.

On *Andropogon leucostachyus* H. B. K.

El Alto de la Bandera, July 15, '15, *8671*.

On *Andropogon bicornis* L.

Las Marias, July 10, '15, *8168*. Vega Baja, July 2, '15, *7751*.

On *Olyra latifolia* L.

El Miradero, Aug. 4, '15, *9159*. Mayaguez Mesa, June 25, '15, *7485*, *7486*, June 29, '15, *7587*, June 24, '15, *7390*. Maricao, July 20, '15, *8959*. San German, June 27, '15, *7518*. Arecibo, Jan. 17, '14, *6805*.

On *Chloris petraea* Sw.

Mayaguez, Aug. 1, '15, *7810*.

On *Ichnanthus pallens* (Sw.) Munro.

Maricao, Apr. 3, '13, *829*. Monte de Oro, Dec. 3, '13, *5755*. Mayaguez Mesa, June 25, '15, *7441*, *7485*.

On *Gramineae* indet.

Monte de Oro, Dec. 3, '13, *5659*. Arecibo, Jan. 17, '14, *6796*. Trujillo Alto, Aug. 15, '15, *9441*.

The type was collected by Heller near Santurce, Porto Rico.

The form on *Panicum glutinosum* and Ichnanthus is usually densely parasitized; the setae do not develop typically, nor are the capitate hyphopodia as likely to be angular as when on the other hosts listed.

The mycelium upon *Lasiacis swartziana, L. divaricata, Paspalum schreberianum,* Olyra, Oplismenus, the Andropogons and Ichnanthus is frequently straight for great distances, but this I take to be due to the surface of the host rather than to a specific difference in the fungus.

57. MELIOLA RUDOLPHIAE sp. nov.

Mycelium strictly epiphyllous in circular spots or diffuse, black. Mycelial setae abundant, long, 400μ, black, tapering, septate, acute, simple; mycelium crooked.

Capitate hyphopodia alternate, stalk cell short, 3-6μ, head cell irregular, usually bent to one side, 10 x 17μ. Ampulliform hyphopodia alternate, 7 x 21μ.

Perithecia numerous, clustered, black, 150-170μ, slightly flattened, cup-shaped when dry, rough with low tubercles. Asci 4-spored, 65 x 27μ. Spores 4-septate, dark brown, ends rounded, constriction moderate, 48-51 x 17-20μ.

On *Rudolphia volubilis* Willd. Fig. 41.

Monte Alegrillo, Maricao, Nov. 14, '13, *4791* (type). Maricao, Nov. 18, '13, *4835*. Luquillo Forest, Dec. 2, '13, *5439*. El Alto de la Bandera, July 10, '15, *8698*. Aibonito, July 16, '15, *8467*.

This species resembles *M. montagnei,* differing from it in color, spores, thickness, and density of mycelium.

58. MELIOLA SERJANIAE sp. nov.

Colonies hypophyllous, irregular, black, 1-6 mm. in diam. Mycelium forming a loose network of threads which branch irregularly, 6μ in diameter.

Capitate hyphopodia small, alternate or irregular, distant, 40-70μ apart, head cell ovoid or pyriform and much lobed, 17 x 10μ, the basal cell 3-6μ. Mucronate hyphopodia usually more abundant than the capitate hyphopodia, opposite, bottle-shaped to conic, narrow, 24 x 6μ. Perithecial setae none. Mycelial setae abundant, black throughout, straight or slightly curved, 280-800 x 10μ. Tip abruptly acute.

Perithecia 150-190μ, smooth. Asci soon evanescent; ascospores 4-septate, brown, constricted, obtuse, 41 x 17μ.

On *Serjania polyphylla* (L.) Rad. Fig. 42.

Vega Baja, Feb. 22, '13, *425* (type). Florida Adentro, July 1, '15, *7654*. Arecibo-Lares Road, June 21, '15, *7219*. Cataño, Nov. 6, '13, *4181*.

This form is clearly differentiated from *M. parenchymate, M. ambigua*, and *M. thouiniae* previously described on the Sapindaceae, all of which have simple mycelial setae. The chief characters are angular, capitate hyphopodia, long, abruptly pointed setae, and numerous mucronate hyphopodia.

59. MELIOLA DIPHOLIDIS sp. nov.

Colonies amphigenous, irregular, circular, 2-5 mm. in diam. Mycelium black, forming a loose network, 7μ in diameter, branches mainly opposite.

Capitate hyphopodia small, alternate or irregular, not crowded, 1 per cell, cells about 27μ long, head cell obovoid to pyriform or globular, often angular or bent, 17 x 10μ, the basal cell 5-7μ long. Mucronate hyphopodia alternate or opposite, wedge to bottle-shaped, 18 x 7μ. Perithecial setae none. Mycelial setae few, straight or slightly curved, 400 x 7μ, dark throughout, tip acute.

Perithecia 110-150μ, slightly rough with rounded protuberances. Asci 2-spored, soon evanescent; ascospores 4-septate, brown, cylindrical, elliptical, distinctly thicker at the middle than toward the ends, strongly constricted, obtuse, 41-44 x 18μ.

On *Dipholis salicifolia* (L.) A.DC.

Guayanilla, July 14, '15, *8549* (type). Quebradillas, June 20, '15, *7265*.

This species differs from *M. amphitricha* in shape of the capitate hyphopodia and spores and from *M. brasiliensis* in character of spores and setae.

60. MELIOLA OCOTEICOLA sp. nov.

Colonies amphigenous, irregular, 3-10 mm. in diam., confluent. Mycelium forming a rather loose network of threads, branches mostly opposite, 7μ in diameter.

Capitate hyphopodia alternate, not crowded, about 30μ apart, cylindrical, head cell scarcely thicker than the stalk, apex obtuse, the basal cell very short. Mucronate hyphopodia few and scattered, usually opposite, conical to bottle-shaped, 20 x 6μ. Perithecial setae none. Mycelial setae few, straight or slightly curved, 300-350μ, dark, tip acute.

Perithecia 150μ, ostiole none. Asci soon evanescent; ascospores 4-septate, brown, strongly constricted, obtuse, 40 x 17μ.

On *Ocotea leucoxylon* (Sw.) Mez. Fig. 43.

Mayaguez, June 29, '15, *7560* (type). Monte Alegrillo, near Maricao, Nov. 14, '13, *4762*.

On *Chrysophyllum* sp.

Monte Alegrillo, Nov. 14, '13, *4731* (type), Nov. 18, '13, *4519*.

In characters of the capitate hyphopodia this is similar to *M. magnoliae* but is still clearly distinct from that form.

Nos. 4579 and 4731 on Chrysophyllum present in the hypophyllous colonies a peculiar variation, in that the mycelium is exceedingly crooked and irregular. These represent, perhaps, a distinct species, but on account of the general resemblance of the capitate hyphopodia and the setae to the other form of Chrysophyllum, they are regarded as co-specific with it.

61. MELIOLA PAULLINIAE sp. nov.

Colonies black, setose, circular, epiphyllous, 3-8 mm. in diam. Mycelium forming a loose network of straight, radiating threads, 8μ thick, branches mostly opposite.

Capitate hyphopodia alternate, often at right angles to mycelium, not crowded, 1 per cell, cells about 34μ long, head cell ovate, 17 x 14μ, stalk cell short. Mucronate hyphopodia usually opposite, bottle-shaped, neck narrow. Perithecial setae none. Mycelial setae abundant, straight, simple, black throughout, rigid, abruptly acute, 275-500 x 8-9μ.

Perithecia 150-160μ. Asci evanescent, spores 37-40 x 14-15μ, 4-septate, constricted, obtuse.

On *Paullinia pinnata* L.

Mayaguez, May 3, '13, *1149* (type), Oct. 31, '13, *3956*, *3914*, *3967*a. Vega Baja, Feb. 22, '13, *376*. El Alto de la Bandera, July 16, '15, *8722*. Rio Arecibo, K. 64.7, July 8, '15, *7787*. Barros, Jan. 2, '13, *55*.

On *Casearia ramiflora* Vahl.

Martin Peña, Aug. 11, '15, *9306*, *9328*. Barceloneta, Aug. 10, '15, *9256*. Manati, July 2, '15, *7688*. Vega Baja, March 1, '13, *512*, July 2, '15, *7745*, Nov. 5, '13, *4262*, March 2, '13, *510*. St. Ana, Dec. 31, '13, *6683*. San German, Dec. 12, '13, *5844*.

On *Casearia sylvestris* Sw.

Mayaguez Mesa, June 29, '15, *7566*, June 14, '15, *7017*, May 1, '13, *1051*, May 4, '13, *1200*. Miradero, Aug. 4, '15, *9136*. Arecibo-Lares Road, June 21, '15, *7285*. San German, Dec. 12, '13, *5837*, *5864*.

On *Casearia arborea* (L. Cl. Rich.) Urb.

Monte de Oro, Dec. 13, '13, *5709*.

On *Casearia aculeata* Jacq.

Lajas, June 17, '15, *7151*.

On *Casearia sp.*

Dos Bocas, below Utuado, Dec. '17, '15, *6071*. Mayaguez, June 15, '15, *7074*, Oct. 31, '13, *3935*. *3920*.

The specimens on Casearia differ somewhat from those on Paullinia, especially in the character of the setae.

On *Mammea americana* L.

Maricao, Sept. 20, '13, *3641*. Las Marias, July 10, '15, *8207*.

On host unknown, Martin Peña, Aug. 11, '15.

The specimens upon Mammea show distinctly longer and more slender setae than those on other hosts and are perhaps specifically distinct.

According to the keys of Gaillard this species would be identified as *M. polytricha*, K. and C., therefore, for purposes of comparison, I am publishing a photograph of the type of *M. polytricha*, fig. 44.

62. Meliola chamaecristae Earle

Bull. N. Y. Bot. Gard. 3: 304, 1905.

Described "on *Chamaecrista glandulosa,*" collected by Heller, No. *6371.*

63. Meliola earlii sp. nov.

Colonies amphigenous, irregular, 1-4 mm. in diam. Mycelium forming a loose network of crooked threads which branch irregularly, often angling at the hyphopodia, about 6μ in diam.

Capitate hyphopodia small, alternate, not crowded, about 25μ apart, ovoid or pyriform, sometimes angular or bent, 8 x 10μ, the basal cell short. Mucronate hyphoodia few, bottle-shaped. Perithecial setae none.

Mycelial setae few or numerous, about 160μ long, straight or slightly curved, opaque, tip acute.

Perithecia 160μ, rough with rounded protuberances, ostiole none. Asci soon evanescent; ascospores 4-septate, brown, somewhat constricted, obtuse, 35-40 x 10μ.

On *Pilea* sp. Fig. 45.

Florida Adentro, July 1, '15, *7685* (type).

On *Pilea parietaria* (L.) Bl.

Rio Arecibo K. 64.7, July 8, '15, *7804.*

On *Pilea nummularifolia* (Sw.) Wedd.

Jajome Alto, Dec. 3, '13, *5640.*

The species is associated with a Meliola determined by Earle as *M. triloba* on *Pilea parietaria,* Heller, No. 558. It is differentiated from *M. leptospora* by spore characters. This Meliola though associated with *M. triloba* is clearly distinct from it in the general habit of the mycelium and especially in the presence of mycelial setae on *M. earlii.*

The species is named in honor of F. S. Earle in recognition of his researches upon Porto Rican fungi.

64. Meliola gesneriae sp. nov.

Colonies hypophyllous, circular, 2-8 mm. in diam. Mycelium black, forming a close network, 7μ in diameter, branches mostly opposite.

Capitate hyphopodia alternate, not crowded, 1 per cell, cells about 24μ long, head cell ovate to globular, 10 x 14μ, the basal cell 4-6μ long. Mucronate hyphopodia alternate or opposite, bottle-shaped. Perithecial setae none. Mycelial setae straight or slightly curved, 400 x 7μ, dark throughout, most abundant around the perithecia. Tip acute.

Perithecia 110μ, smooth. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, 41 x 17μ.

On *Gesneria albiflora* (Dcne.) O. Ktz.

Mayaguez Mesa, June 25, '15, *7431* (type), *7465*. Dos Bocas, below Utuado, July 8, '15, *8018*, Dec. 30, '13, *6590*.

On *Cestrum laurifolium* l'Her.

Maricao, Apr. 3, '13, *824*.

On *Cestrum macrophyllum* Vent.

El Alto de la Bandera, July 14, '15, *8301*.
El Gigante, July 16, '15, *8561*.

65. MELIOLA JATROPHAE sp. nov.

Colonies epiphyllous, circular to irregular, 1-4 mm. in diam. Mycelium forming a loose network of threads; branches mostly opposite, 7μ in diameter.

Capitate hyphopodia alternate or irregular, forming an acute angle with the mycelium, not crowded, about 27μ apart, head cell ovate, 17 x 7μ, apex obtuse, the basal cell short. Mucronate hyphopodia abundant and crowded on certain threads, opposite, bottle-shaped. Perithecial setae none. Mycelial setae few, except around the base of the perithecia where they are numerous, curved, about 250μ long, dark, tip acute.

Perithecia 130-150μ, slightly rough, with rounded protuberances, Asci soon evanescent; ascospores cylindrical, 4-septate, brown, slightly constricted, obtuse, short, thick, 30 x 17μ.

On *Jatropha hernandifolia* Vent.

Rio Tanama, near Arecibo, July 6, '15, *7873* (type). Dos Bocas, near Utuado, July 8, '15, *7930*.

The most distinctive characters are the short, thick ascospores and the ovate, capitate hyphopodia, all directed forward at an acute angle.

66. MELIOLA MAYEPEAE sp. nov.

Colonies amphigenous, more commonly epiphyllous, circular, 1-5 mm. in diam. Mycelium black, forming a rather close network, 7μ in diameter, branches opposite, mostly at acute angles.

Capitate hyphopodia small, alternate, not crowded, 1 per cell, cells about 35μ long, head cell obovoid, 10 x 7μ, the basal cell 3μ long. Mucronate hyphopodia not seen. Perithecial setae none. Mycelial setae few to abundant, most plentiful around the perithecia, slightly curved, about 250 x 6μ, dark throughout. Tip simple, obtuse.

Perithecia 170μ, slightly rough. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 30-35 x 17μ.

On *Mayepea domingensis* Krug and Urb. Fig. 46.

Mayaguez Mesa, June 25, '15, *7468* (type). El Alto de la Bandera, July 16, '15, *8703*.

This species is distinguished from *M. brasiliensis* by the shape of the capitate hyphopodia and the bases of the setae.

67. Meliola gymnanthicola sp. nov.

Colonies epiphyllous, circular, 2-4 mm. in diam. Mycelium forming a close network, 7μ in diameter, branches mostly opposite and often at right angles.

Capitate hyphopodia alternate, not crowded, 1 per cell, cells about 20μ long, head cell ovoid to nearly cylindrical, 17 x 10μ, the basal cell 2-3μ long. Mucronate hyphopodia alternate or opposite, conical to bottle-shaped, irregular, 16-18 x 7μ. Perithecial setae none. Mycelial setae scattered, slightly crooked, 300 x 7μ. Tip obtuse, dark. Perithecia 190μ, slightly rough. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 37 x 17μ.

On *Gymnanthes lucida* Sw.

Guayanilla, July 14, '15, *8596* (type).

68. Meliola lucumae sp. nov.

Colonies amphigenous, much larger below, irregularly circular, 2-10 mm. in diam., diffuse. Mycelium forming a loose network, 7μ in diameter, branches mostly opposite.

Capitate hyphopodia alternate, distant, 1 per cell, cells about 35μ long, head cell cylindrical or tapering slightly at each end, 17 x 7μ, the basal cell 3μ long. Mucronate hyphopodia few, mostly opposite, narrow-conic, about 20 x 4μ. Perithecial setae none. Mycelial setae few slightly curved, 200-800 x 7μ, dark throughout. Tip obtuse.

Perithecia 100-150μ, slightly rough with rounded projections. Asci soon evanescent; ascospores 4-septate, pale brown, slightly contricted, obtuse, 44 x 18μ.

On *Lucuma multiflora* A. DC. Fig. 47.

Las Marias, July 10, '15, *8164* (type).

The distinctive character of the species is the sparse, diffuse, mycelium, with cylindrical, capitate hyphopodia associated with slightly differentiated mucronate hyphopodia.

Guayanilla, July 14, '15, *8596* (type).

69. Meliola amphitrichia Fr.

Elench. Fung. 2: 109, 1828.

Reported by Earle "on leaves of tree." Heller collection, No. 288 near Caguas, 1899.

70. Meliola byrsonimae sp. nov.

Colonies epiphyllous, circular to irregular, 2-5 mm. in diam. Mycelium forming a loose network of threads, 10μ in diam.

Capitate hyphopodia alternate, distant, usually about 120μ apart, cylindrical, 20 x 17μ, often irregular or curved, the basal cell 3-5μ long. Mucronate hyphopodia opposite, bottle-shaped, about 24μ long. Perithecial setae none. Mycelial setae very few, scattered, straight or slightly curved, 1000μ long, dark throughout. Tip obtuse to acute.

Perithecia 150 to 160μ, smooth, subtended when young by an areola of radiate hyphae. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 54 x 18μ.

On *Byrsonima lucida* (Sw.) L. Cl. Rich.

Guayanilla, July 14, '15, *3541* (type).

This is closely related to *M. amphitricha, M. ambigua and M. corallina,* differing from the last two in spore size; differing from the first, in abundance, length and color of setae, and in character of capitate hyphopodia and mycelium.

71. Meliola tabernaemontanae Speg.

Ann. d. Mus. Nac. de Buenos Aires; 33: 42, 1912.

On *Rauwolfia nitida* Jacq.

Martin Peña, Aug. 11, '15, *9327, 9300.*

On *Tabernaemontana oppositifolia* (Spreng.) Urb.

Mayaguez, June 15, '15, *7073.* Hormigueros, K. 7, June 23, '15, *7352.* Mayaguez Mesa, June 29 ,'15, *7558.*

On *Plumiera krugii* Urb.

Maricao, July, 19, '15, *8818.*

These specimens conform perfectly with type material kindly supplied by Dr. Spegazzini.

The most distinctive characters are the regularly shaped, capitate hyphopodia and the black, truncate setae.

71a. Meliola tabernaemontanae. var. forsteroniae var. nov.

The specimens on Forsteronia agree with the type quite closely, but present constant differences in the setae and capitate hyphopodia as follows: The setae are long, about 700μ, and taper to an acute apex. The capitate hyphopodia are larger and more angular than in the type.

On *Forsteronia corymbosa* (Jacq.) Mey.

Utuado, *4682* (type).

72. Meliola ambigua Pat. and Gaill.

Bull Soc. Myc. de Fr. 4: 104, 1888.

On *Lantana odorata* L.

Quebradillas, June 20, '15, *7268, 7267.*

On *Lantana camara* L.

Dos Bocas, below Utuado, July 8, '15, *8016, 8025.* Rio Arecibo, K. 64.7, July 8, '15, *7806.*

On *Lantana* sp.

Quebradillas, Nov. 22, '13, *5008.* Dos Bocas, below Utuado, Dec. 17, '13, *6052,* Dec. 17, '30, '13, *6870.*

73. Meliola psychotriae Earle

Bull. N. Y. Bot. Gard. 3: 308, 1905.

On *Erithalis fruticosa* L.

Quebradillas, Aug. 10, '15, *9240, 9229.* Mona Island, Dec. 20, '13, *6082, 6138, 6254.* Guayanilla, July 14, '15, *8599.* Also collected by Heller on this host, Jan. 19, 1900, No. *6430,* and on Psychotria sps., near Ponce, Dec. 9, 1902.

On *Gonzalagunia spicata* (Lam.) G. Maza.

Sabana Llana, Aug. 13, '15, *9371.* Miradero, Aug. 4, '15, *9134.* Mayaguez, June 24, '15, *7388,* July, '15, *7910,* June 14, '15, *7044, 7046.* Vega Baja, Aug. —, '15, *9271.* Rio Arecibo, K. 64.7, July 8, '15, *7793.* Mayaguez Mesa, June 29, '15, *7592.*

On *Randia aculeata* L.

Quebradillas, June 20, '15, *7301,* Nov. 22, '13, *4985.* Florida Adentro, July 1, '15, *7757.* Hormigueros, June 23, '15, *7351.* Monacillo, Aug. 12, '15, *9353.*

The specimens on this host show slight differentiation in the hyphopodia and setae.

On *Chiococca alba* (L.) Hitch.

Mayaguez Mesa, June 25, '15, *7467.* Rio Tanama, July 6, '15, *7859.* Martin Peña, Aug. 11, '15, *9299.* Hormigueros, June 23, '15, *7325.*

On *Guettarda ovalifolia* Urb.

Maricao, Jan. 10, '12, *234.*

On *Borreria laevis* (Lam.) Griseb.

El Alto de la Bandera, July 14, '15, *8593, 8598.* Dos Bocas, below Utuado, July 8, '15, *8090.*

On *Borreria ocimoides* DC.

One specimen with no data.

On *Rubiaceae* indet.

Guayanilla, July 14, '15, *8550, 8546.*

I find this species also on *Exostema caribaeum* (Jacq.) R. and Sch. collected in Santo Domingo by Taylor, No. *483.*

74. Meliola mayepeicola sp. nov.

Colonies epiphyllous, circular, punctiform, 1-2 mm. in diam. Mycelium black, forming a very close network, 9μ in diameter, branches mostly opposite.

Capitate hyphopodia large, alternate, close, 1 per cell, cells about 20μ long, head cell pyriform, 24 x 17μ, the basal 7μ long. Mucronate hyphopodia few, alternate or opposite, bottle-shaped, crooked, narrow, 16-18 x 6μ. Perithecial setae none. Mycelial setae few, straight or slightly curved, 150 x 7μ, dark throughout, tip obtuse.

Perithecia 100-119μ, slightly rough, with conic projections.

Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 34 x 14μ.

On *Mayepea domingensis* Krug and Urb.

Mayaguez Mesa, June 29, '15, *7556* (type). Maricao, Apr. 3, '13, *822*.

The distinctive characters of this species are close, dense, small colony and thick capitate hyphopodia. The setae are sometimes very scant and may perhaps be entirely wanting. Most leaves which bear this fungus are infested with *M. mayepeae* also, but the two are readily separable by the naked eye.

75. MELIOLA CLUSIAE sp. nov.

Colonies hypophyllous, irregular, diffuse, 3-5 mm. in diam. Mycelium brown, 8μ thick, nearly straight, branching mostly opposite.

Capitate hyphopodia alternate, 1 per cell, cells about 30μ long. Head cell ovate to elliptical, more rarely cylinder or irregular, 20 x 14μ, stalk cell 2-4μ long. Mucronate hyphopodia scattered, 20 x 7μ, bottle-shaped. Perithecial setae none. Mycelial setae few, 800 x 10μ at base, tips obtuse, brittle, usually broken, mostly clustered around the perithecia.

Perithecia apparently dimidiate, with an areola of radiating hyphae. Spore 61 x 20μ, strongly constricted, obtuse, cylindrical.

On *Clusia minor* L.

El Alto de la Bandera, July 15, *8571,* July 15, '15, *8283* (type).

SECTION F.

Spores 4-septate, no perithecial setae or appendages, mycelial setae simple, uncinate. There are only two species known in Porto Rico.

KEY TO SPECIES OF SECTION F.

Capitate hyphopodia crowded	M. guareicola No. 76
Capitate hyphopodia not crowded	M. tecomae No. 77

76. Meliola guareicola sp. nov.

Colonies epiphyllous, circular, punctiform, 1-4 mm. in diam., black. Mycelium dense, forming a close mat of threads which readily separates as a whole from the substratum.

Capitate hyphopodia alternate or irregular, crowded, head cell globular, ovoid or pyriform, 14 x 10μ, the basal cell 2-3μ long. Mucronate hyphopodia alternate or opposite, bottle-shaped, the neck narrow, 16-18 x 7μ. Perithecial setae none. Mycelial setae numerous, forming a dense mat covering the colony to the edge, 200-300μ long, 7μ thick, dark, pale at tip, upper part strongly coiled or twisted. Tip acute.

Perithecia small, 100-500μ, distinctly ostiolate. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 37 x 10μ.
On *Guarea trichilioides* L.

Las Marias, July 10, '15, *8166* (type), July 11, '15, *8245*. Mayaguez Mesa, June 25, '15, *7464*. Adjuntas, Nov. 22, '13, *4971*. Monte de Oro, near Cayey, Dec. 3, '13, *5737*. Dos Bocas, below Utuado, July 8, '15, *8096*.

This species is usually associated with *M. guareae* from which it is readily distinguished by its uncinate hairs.

77. Meliola tecomae sp. nov.

Colonies amphigenous, mainly epiphyllous, circular, 2-5 mm. in diam. Mycelium black, forming a close network of threads, 7μ in diameter, branches mostly opposite.

Capitate hyphopodia alternate, not crowded, 1 per cell, cells, about 35μ long, head cell ovoid, 17 x 13μ, the basal cell 6-10μ long. Mucronate hyphopodia opposite, irregularly conic, 16-18 x 6μ, no well differentiated neck. Perithecial setae none. Mycelial setae abundant, broadly curved into a large hook at the end, 170 x 10μ, dark throughout, tip obtuse.

Perithecia 170μ, slightly rough with rounded protuberances. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, 44 x 17μ.
On *Tecoma pentaphylla* (L.) Juss. Fig. 48.

Martin Peña, Aug. 11, '15, *9332* (type), Mayaguez, June 24, '15, *7396*, *7078*. Las Marias, July 10, '15, *8177*. Maricao, July 20, '15, *8960*.
On *Tecoma* sp.

El Miradero, Aug. 4, '15, *9163*. Las Marias, March 22, '13, *3593*. Mayaguez, Oct. 31, '13, *3950*. Maricao, Nov. 18, '13, *4804*. Quebradillas, Nov. 22, '13, *4978*, *4981*. Vega Baja, Nov. 5, '13, *4310*a. Arecibo-Lares Road, Jan. 21, '14, *6790*.

The distinguishing character is the long, broadly curved or hooked, black, setae. They, in general, resemble those figured by Gaillard for *M. balansae* or *M. intermedia,* but the agreement goes no further. There is a strong superficial resemblance to *M. pazschkeana,* but the two are readily distinguished by their very different mucronate hyphopodia.

A specimen on Tecoma which I have not seen, labelled *M. pazschkeana,* in the Bronx herbarium may possibly belong here.

Section G

Spores 4-septate, no perithecial appendages, mycelial setae both simple and forked.

Key to Species of Section G[1]

Capitate hyphopodia opposite	M. ipomoeae No. 78
Capitate hyphopodia not usually opposite	
Setae very long, 1000μ	M. guareae No. 79
Setae shorter	
Capitate hyphopodia very narrow, scarcely thicker than the stalk cell	M. magnoliae No. 80
Capitate hyphopodia thicker	
Head cell nearly globular	M. bicornis No. 95
Head cell more or less elongated	
Capitate hyphopodia often opposite	M. smilacis No. 81
Capitate hyphopodia alternate	
Head cell regular	M. helleri No. 82
Head cell irregular	
Setae sometimes forked	M. mangiferae No. 83
Setae merely denticulate	M. denticulata No. 84

78. Meliola ipomoeae Earle (Not *M. ipomoeae* Rehm[2])

Muhlenbergia 1: 10, July 1901.

On *Ipomoea cathartica* Poir.

Las Marias, July 10, '15, *8183.* Vega Baja, July 2, '15, *7729.* El Alto de la Bandera, July 16, '15, *8692.*

On *Ipomoea tiliacea* (W.) Choisy.

Añasco, Oct. 12, '13, *3506.* Mayaguez, Oct. 31, '13, *3909.*

On *Ipomoea* sps. Fig. 49.

El Miradero, Aug. 4, '15, *9160.* Dos Bocas, below Utuado, July 8,

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[1] *M. stenotaphri* which *very rarely* has bifid setae is to be found in section E.

[2] The use of this specific name by Rehm (Ann. Myc. 12: 171, 1914) is clearly invalidated by the prior use by Earle and *M. ipomoeae* Rehm becomes *M. ipomoeaephile* Rehm, in lit.

'15, *8083.* Dec. 30, '13, *6563.* Rosario, No. *4810.* Maricao, July 19, '15, *8784, 9001.*

The type was collected near Mayaguez by Heller, No. *4358,* in 1900. A specimen from the Bronx Garden, No. *6258,* determined by Earle, shows the capitate hyphopodia to be almost exclusively opposite. Although this character is not mentioned by Earle in his description it appears to me to be the most distinctive feature of the species. The perithecia instead of being "few, 2-4," as described, are very numerous, 20+ per colony. The forward angling of the hyphopodia appears to me to be a variable character.

This fungus frequently grows upon the same leaf with *M. clavulata* which it resembles very closely, with the exception of the setal tips and the arrangement of the capitate hyphopodia.

79. MELIOLA GUAREAE Speg.

Ann. d. Mus. Nac. de., Buenos Aires, 23: 42, 1912.

On *Guarea trichilioides* L.

Las Marias, July 10, '15, *8166* (type). Dos Bocas, below Utuado, July 8, '15, *8096.* Monte de Oro, Dec. 3, '13, *5737.* Adjuntas, Nov. 22, '13, *4971.* Jajome Alto, Dec. 3, '13, *5691.* Mayaguez Mesa, June 25, '15, *7464.* Usually associated with *M. guareicola* but on the lower side of the leaves.

These specimens differ from the type, which was sent to me by Dr. Spegazzini, in that they have larger hyphopodia, more abundant setae, and in minor colony characters, especially in density of growth. The setae with forked tips are rare and the fact that this character was not mentioned by Spegazzini is not significant.

80. MELIOLA MAGNOLIAE sp. nov.

Colonies hypophyllous, irregular, 3-20 mm. in diam., black. Mycelium forming a very loose network of threads, 7μ in diameter.

Capitate hyphopodia alternate or irregular, distant, about 45μ apart, head cell cylindrical, very little thicker than the stalk cell, straight or somewhat curved, obtuse, the basal cell about 7μ long.

Mucronate hyphopodia opposite or irregular, almost cylindrical to slightly bottle-shaped, 20μ long. Perithecial setae none. Mycelial setae few, about 700μ long, straight or slightly curved, opaque. Tip acute, simple or occasionally forked, with short teeth.

Perithecia 200μ in diam., slightly rough with rounded protuberances, ostiole none. Asci soon evanescent; ascospores 4-septate, dark brown, very strongly constricted, obtuse, 51 x 20μ.

On *Magnolia portoricensis* Bello. Fig. 50.

Monte Alegrillo, near Maricao, Nov. 14, '13, *4738* (type).

This species is remarkable for the slight differentiation of its capitate and mucronate hyphopodia which differ from each other but little and also very much resembles branches, though of determinate growth. This is evidently one of the most primitive forms in the genus.

81. MELIOLA SMILACIS sp. nov.

Colonies amphigenous but more abundant above, circular, irregular, 2-4 mm. in diam. Mycelium not crooked, of medium density, branches opposite.

Capitate hyphopodia alternate, opposite or unilateral, head cell cylindrical to globular, 14 x 11μ, stalk cell short, about 4μ. Mucronate hyphododia rare, conical, neck short and tapering, or ampulliform with neck longer. Mycelial setae abundant, about 500μ high, tapering, 10μ thick at base, apex obtuse, rarely bifid, pale, base opaque.

Perithecial setae or appendages none. Perithecia about 200μ in diam. Ostiole a mere thinning of the apical region. Asci soon evanescent, short type. Spores 4-septate, but slightly constricted, ends obtuse, 15 x 17μ.

On *Smilax coriacea* Spreng.

Manati, Nov. 25, '13, *5261* (type).

On *Smilax* sp. indet.

Jajome Alto, July 17, '15, *8429*.

The two hosts appear to be quite different but it is possible that the latter specimen is a form of *S. coriacea*.

This Meliola belongs to the group of *M. amphitricha* from which it is distinguished by its ostiole, which is however, very difficult of observation, by the sometimes forked tips of the mycelial setae and by the capitate hyphopodia.

82. MELIOLA HELLERI Earle

Bull. N. Y. Bot. Gard. 3: 307, 1905.

The type is on an ''unknown woody plant perhaps belonging to the Myrtaceae'', Heller No. 6251, 3 miles west of Ponce, Dec. 9, 1902.

The setae in the cotype specimen which I examined were more frequently simple than forked as called for in the description.

On *Eugenia stahlii* (Kiaer.) K. and Urb.

Luquillo Forest, Dec. 4, '13, *5343*. El Alto de la Bandera, July 15, '15, *8665*. Jajome Alto, July 17, '15, *8436*.

The specimens are much overgrown by parasites. Setae were seen upon one specimen, but all were simple.

On *Eugenia monticola* (Sw.) P. DC.
Manati, Nov. 5, '13, *4285*.
On *Myrcia deflexa* (Poir) P.
El Alto de la Bandera, July 14, '15, *8268, 8268, 8672*.

This collection is heavily overgrown by parasites and the determination is therefore not fully reliable. The typical setae were not seen but the character of the mycelium and capitate hyphopodia were those of *M. helleri.*

On *Myrcia splendens* (Sw.) P. DC.
Jajome Alto, Dec. 3, '13, *5646*.

83. Meliola mangiferae Earle

Bull. N. Y. Bot. Gard. 3: 307, 1905.

On *Mangifera indica* L.
Mayaguez, Aug. 5, '15, *9478*, Jan. 8, '14, *6723*, June 16, '15, *7109*. Vega Baja, Feb. 23, '13, *440*. Manati, Nov. 5, '13, *4300*. Luquillo Forest, Dec. 2, '13, *5558*, *5428*. El Gigante, near Adjuntas, Dec. 15, '13, *6016*. Collected also by Heller, No. *6393*, near Rio Piedras, Jan. 9, 1903.

In many cases the colonies, particularly epiphyllous colonies, lack the usual velvety appearance, have few setae, a loose mycelium instead of the dense mycelium, and lack the numerous hairs that characterize the large black hypophyllous blotches. The forking of the setae seems to be the exception rather than the rule.

84. Meliola denticulata Wint.

Gaillard, Le Genre Meliola: 98, 1892.

On *Roystonea borinquena* Cook.
Arecibo-Lares Road, June 21, '15, *7279*.

Section H

Spores 4-septate, no perithecial appendages, mycelial setae forked.

Key to Species of Section H

Apical branches strongly divergent, well-developed	
Primary branches at nearly right angles	
Primary branches long, 15+μ	
Secondary branches well developed	M. cucurbitacearum No. 85
Secondary branches merely toothed	M. furcata No. 86
Primary branches short, 4-10μ	M. hessii No. 87
Primary branches not at right angles	

Primary branches short, 18μ	M. piperis No. 88
Primary branches longer	
Capitate hyphopodia mostly opposite	
Secondary and tertiary branches well developed	M. quadrispina No. 89
Tertiary branches often not developed	M. philodendri No. 90
Capitate hyphopodia alternate	M. merrillii No. 91
Apical branches merely teeth or not strongly divergent	
Apical teeth crowded, forming a crest	M. gaillardiana No. 92
Apical teeth not crowded to form a crest	
Setae very dark	
Setae about 400μ long, hyphopodia largely opposite	M. dieffenbachiae No. 93
Setae about 300μ long	M. bidentata No. 94
Setae translucent	M. bicornis No. 95

85. MELIOLA CUCURBITACEARUM sp. nov.

Colonies epiphyllous, circular, 1-3 mm. in diam. On leaves and stems. Mycelium black, forming a rather close network, 7μ in diameter, branches mostly alternate.

Capitate hyphopodia alternate, not crowded, 1 per cell, cells about 17 to 24μ long, head cell ovoid, lobed, 17 x 14μ, the basal cell 7μ long. Mucronate hyphopodia alternate or opposite, bottle-shaped, 20 x 5μ, neck narrow and crooked. Perithecial setae none. Mycelial setae abundant in the older parts of the colony, 190 x 9μ, dark throughout. Tip once or twice dichotomous, branches standing at nearly right angles to the main axis, primary branches 15-35μ, secondary about the same, apices acute. Perithecia 120μ, rough with rounded protuberances. Asci soon evanescent; ascospores 4-septate, brown, slightly constricted, obtuse, 41 x 14μ. On leaves and stems of an unknown Cucurb, probably Cayaponia.

El Alto de la Bandera, July 16, '15, *8732* (type). Fig. 51.

The species is readily recognized by its characteristic, once or twice dichotomous setae and its lobed capitate hyphopodia.

86. MELIOLA FURCATA Lev.

Ann. Sc. Nat. 266, 1846.

On *Coccothrinax alta* (Cook) Becc.

Dos Bocas, below Utuado, Dec. 17, '13, *6060*.

On *Acrista monticola* Cook.

El Alto de la Bandera, *8303 a*. Luquillo Forest, Dec. 4, '13, *5400*.

On *Thrinax ponceana* Cook.

Guayanilla, July 14, '15, *8590*, *8017*, July 26, '15, *9074*.

On *Thrinax praeceps* Cook.

Dos Bocas, below Utuado, July 8, '15, *8017*.

On *Macrodiscus lactiflorus* (Vahl.) Bur.[1]

Coamo, Apr. 6, '13, *850 a*.

87. Meliola hessii sp. nov.

Colonies epiphyllous, irregular, orbicular, 2-3 mm. in diam. Centers denuded when old. Mycelium straight, forming a close network of threads, branches mostly opposite, 7μ in diameter.

Capitate hyphopodia opposite, crowded, about 17μ apart, head cell pyriform, 7 x 10μ, the basal cell 3μ long. Mucronate hyphopodia opposite, bottle-shaped. Perithecial setae none. Mycelial setae erect, rigid, not very numerous, uniformly about 190μ high, 8μ thick. Tip divided dichotomously, once, twice or thrice, into short branches which stand out nearly at right angles to the main stalk. Setal branches about 15μ long.

Perithecia 150μ, minutely rough. Asci soon evanescent, 4-spored; ascospores 4-septate, brown, slightly constricted, obtuse, 41 x 14μ.

On *Paullinia pinnata* L. Fig. 52.

Sabana Llana, Aug. 13, '15, *9367* (type). Mayaguez, May 4, '13, *1207*b.

Named in honor of Mr. W. E. Hess who collected largely in Porto Rico.

The species is remarkable for its straight, rigid setae of characteristic branching. Its characters are so marked that it is separated readily by the naked eye from the other species on Paullinia.

88. Meliola piperis Earle

Muhlenbergia 1: July 1901, 12.

On *Piper adunctum* L.

Dos Bocas, below Utuado, July 7, '15, *7964*. Las Marias, July 10,

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[1] The determinations of the Meliolas on Palms were all made by Mr. W. E. Pickler, who has made a special study of the variability of the setal tips of *M. furcata*.

'15, *8603*. Maricao, April 3, '13, *758*. Monte de Oro, near Cayey, Dec. 3, '13, *5678*.

The type was collected by Heller on *P. aduunctum* near Mayaguez, Jan. 1900, No. 4359 b.

89. MELIOLA QUADRISPINA Rac.

Parasit. Algen. u. Pilze, Javas, III, 33, 1900.

Meliola quadrifurcata Rehm. Leaflets of Philippine Bot. 6: 2194, 1914.

On *Ipomoea cathartica* Poir. Fig. 53.

Las Marias, July 10, '15, *8163*.

In general aspect of the colony and in the shape of the hyphopodia there is a striking similarity among the three species above recorded on the Convolvulaceae, which may point to a close relationship between them. This very beautiful species differs from all others that I have seen in its delicately forked setae, which are indeed the striking characters of the colony. Both types of hyphopodia are strictly opposite though this character is not mentioned in the original description.

90. MELIOLA PHILODENDRI sp. nov.

Colonies chiefly epiphyllous, circular, black, 1-5 mm. in diam., velvety. Mycelium coarse, 8μ, straight, branches opposite at uniform angles, setigerous close to the margin of the colony.

Capitate hyphopodia mostly opposite, about 20-30μ apart, stalk cell short, 3μ, head cell oval, not angular, 10 x 14μ. Mucronate hyphopodia scarce, ampulliform, alternate or opposite, often crowded, mycelial setae long, 230-300μ, black, at base about 9μ thick, dichotomous, forking three or more times, ultimate branches acute, branches about 120μ long.

Perithecia about 185μ in diam. Spores cylindrical, obtuse, 4-septate, only slightly constricted, 48-54 x 15-20μ. Spores sometimes narrower and much constricted, becoming moniliform in appearance.

On *Philodendron krebsii* Schott. Fig. 54.

Arecibo-Lares Road, June 21, '15, *7225* (type). Jayuya, March 2, '13, *377*, Mch. 1, '13, *437*. Ponce, Nov. 8, '13, *4346*. Jajome Alto, July 17, '15, *8424*. Maricao, July 20, '15, *8994*. El Alto de la Bandera, July 16, '15, *8712*.

The long, branching, dichotomous setae, together with the opposite hyphopodia distinguish this species. The species is a conspicuous one and is of common occurrence in Porto Rico wherever the host is found.

91. Meliola merrillii Syd.

Phil. Jour. Sc. 8 C 6: 479, 1913.

On *Cissus sicyoides* L.

San German, Dec. 12, '13, *5846*, Nov. 8, '13, *5789*, *5788*. Lares, Nov. 22, '13, *4841*. Utuado, Nov. 8, '13, *4418*, *4398*. Villa Alba, Jan. 3, '12, *101*. El Gigante, near Adjuntas, Dec. 15, '13, *5819*. Dos Bocas, below Utuado, Dec. 17, '13, *6063*, July 8, '15, *8101*, July 7, '15, *7968*. Añasco, Oct. 12, '13, *3565*. Aguada, Nov. 22, '13, *5102*. Yauco, Oct. 3, '13, *3145*, *3143*. Mayaguez, Oct. 31, '13, *3948*, *3910*. Rio Tanama, July 6, '15, *7913*. Manati, July 2, '15, *7690*.

The type is on Cissus leaves collected in Luzon by Merrill. A cotype specimen was kindly sent to me by Doctor Merrill, also by Dr. H. Sydow, and comparison clearly verifies the determination, though there are certain minor differences. In particular, the mycelium in the Porto Rican specimens is much more dense and luxuriant.

92. Meliola gaillardiana sp. nov.

Colonies epiphyllous, small, circular, 1-2 mm. in diam., black; mycelium irregular, crooked, forming a very close, dense network of threads about 9μ thick, cells about 14μ long.

Capitate hyphopodia small, alternate or irregular, crowded, about 7-17μ apart, ovoid, pyriform or curved, 10μ in diam., the basal cell 5-6μ long. Mucronate hyphopodia few and scattered, alternate or opposite, bottle-shaped, the neck narrow. Mycelial setae abundant, straight, rigid, 220μ long, 10μ thick, opaque; at tip bearing a crest, about 17-34μ, of short, acute spines; sometimes forking below this crest. Perithecial setae none.

Perithecia 170μ in diam., slightly rough with rounded protuberances of small, 6μ, subprominent cells, ostiole none. Asci soon evanescent; ascospores 4-septate, brown, very slightly constricted, obtuse, terminal cells longer than the others, 3 x 14μ.

On *Piper aduncatum* L. Fig. 55.

Rio Arecibo, July 8, '15, *7794* (type), *7796*. Dos Bocas, below Utuado, July 8, '15, *8044*, Dec. 30, '13, *6802*. Las Marias, July 11, '15, *8223*.

The crests at the apices of the mycelial setae are very distinctive. They seem to be due to a very close, dichotomous branching. The form is most nearly related to *M. piperis* but is separated from that species by the setal tips and the density of mycelium. It differs much from *M. pululahuensis* in its mycelial tips. The difference from *M. patouillardi* is less, still the form appears to be distinct from both.

Named in honor of A. Gaillard in recognition of his extensive studies of the genus Meliola.

93. Meliola dieffenbachiae sp. nov.

Colonies amphigenous with a tendency to be more numerous above but larger below, 1-5 mm. in diam., black, velvety.

Mycelium branches usually opposite at uniform angles forming a rather dense mat. Capitate hyphopodia alternate or opposite, oblong, spherical or curved, basal cell 4μ long, head cell 10-14μ. Mucronate hyphopodia few, alternate or opposite. Mycelial setae rigid, black, straight, about 400μ long, short branched or merely toothed apex. Teeth of varying number and size. Perithecial setae or appendages none. Asci soon evanescent, 2-4-spored. Spores cylindrical, 40 x 14μ, 4-septate, ends obtuse, slightly constricted at the septa, end cells rather larger than the others.

Perithecia grouped in center of colony, numerous, 140-170μ in diam. On *Dieffenbachia sequine* (Jacq.) Schott. Fig. 56.

Las Marias, July 10, '15, *8148* (type), *8210*. Maricao, Oct. 18, '13, *3889*, July 19, '15, *8851*. Cataño, July 2, '15, *7707*. Lajas, June 17, '15, *7155*. Monte de Oro, near Cayey, Dec. 3, '13, *5666*, *5731*. Dos Bocas, below Utuado, July 8, '15, *8074*, *8077*. Mayaguez, June 24, '15, *7420*.

This differs strikingly from *M. philodendri* in the branching of its setae. It resembles *M. fuscidula* but differs from it in the character of the setae.

94. Meliola bidentata Cke.

Grev. 11: 37, 1882.

On *Tecoma pentaphylla* (L.) Juss.

Guanajibo, June 19, '15, *7202*, *9002*. Hormigueros, K. 7, June 23, '15, *7347*.

On *Tabebuia haemantha* (B.) Gris.

Monte Alegrillo, *4716*.

On unknown dicot, St. Ana, July 1, '15, *7621*, *7633*.

The above named specimens were compared with and agree with a specimen obtained from the Kew Gardens. (Ravenel Fung. Amer. Exs.—No. 330,) there labeled "*M. furcata*, Lev." but also labeled in Cooke's writing "not furcata Lev. but bidentata Cke. M.C.C."

95. Meliola bicornis Wint.

Hedw. 26: 99, 1886.

On *Meibomia axillaris* (Sw.) O. Ktz. Fig. 57.

Florida Adentro, July 1, '15, *7653*. Las Marias, July 10, '15, *8179*. Mayaguez, June 24, '15, *7395*. Rio Arecibo, K. 64.7, July 8, '15, *7791*. Rio Tanama, July 6, '15, *7838*.

On *Meibomia adscendens* (Sw.) Kuntz.

El Alto de la Bandera, July 15, '15, *8531*, *8648*.

On *Meibomia supina* (Sw.) Britt.

Cataño, Dec. 3, '13, *4532*. Martin Peña, Aug. 11, '15, *9309*. Maricao, July 19, '15, *8793*, July 20, '15, *8975*. Vega Baja, July 2, '15, *7750*. Mayaguez, July 3, '15, *8094*. Florida Adentro, July 15, '15, *7666*. Rio Tanama, July 6, '15, *7854*. Dos Bocas, below Utuado, July 8, '15, *8022*. El Gigante, near Adjuntas, Dec. 15, '13, *5820*. Indiera Fria, Oct. 8, '13, *3370*.

On *Dalbergia monetaria* L. fil.

Mayaguez Mesa, June 25, '15, *7476*. Arecibo-Lares Road, June 21, '15, *7243*. Maricao, Sept. 20, '13, *3658*.

On *Dalbergia* sps.

Mayaguez Mesa, June 29, '15, *7577*. Rosario, Apr. 3, '13, *711*, July 4, '15, *9016*.

On *Bradburya virginiana* O. Ktz.

Arecibo-Lares Road, June 21, '15, *7242*. Manati, July 2, '15, *7694*. Dos Bocas, below Utuado, July 8, '15, *8043*. Vega Baja, July 2, '15, *7749*. Quebradillas, Nov. 22, '13, *5036*.

On *Mimosa ceratonia* L.

Maricao, July 20, '15, *8899*, *8868*. Rio Arecibo, K. 64.7, July 8, '15, *7770*. Vega Baja, July 2, '15, *7744*. Aibonito, Nov. 3, '13, ***4020***.

On *Lonchocarpus glaucifolius* Urb.

Quebradillas, June 20, '15, *7264*.

On *Erythrina micropteryx* Poepp.

El Miradero, Aug. 11, '15, *9166*.

On *Teramnus uncinatus* (L.) Sw.

Maricao, 3503, Jan. 10, '12, *228*. Añasco, Oct. 12, '13, *3583*, *3537*. Yauco, Oct. 3, '13, *3136*.

The form on Teramnus, Nos. 6554, 3583, 3503, is much branched at the apices.

On *Dolicholos reticulatus* Millsp.

Florida Adentro, July 1, '15, *7682*, *7675*. Vega Baja, Nov. 5, '13, *4263*. Lares, Nov. 22, '13, *4933*. Quebradillas, Nov. 22, '13, *4982*. Barceloneta, Aug. 10, '15, *9259*. Rio Tanama, Aug. 6, '15, *7875*.

On an unknown Legume by Heller, *6259*.

This series of specimens on the various hosts shows considerable variation, particularly as to setal apices. The mycelium and the capitate hyphopodia, however, are quite characteristic and I am therefore inclined to include all of these forms, growing as they do upon members of one family, in one single species, recognizing as varieties such as show well-marked and constant difference. These differences are usually in the setae, which on some hosts are almost invariably simple, on others slightly toothed, and on still others much toothed and contorted.

The species as manifest on some of its hosts clearly agrees with *M. bicornis* Wint of Rabenhorst's Fungi Europaei, No. 3545, collected on an unknown legume in Brazil, May 1885; with an authentic specimen kindly loaned from the Kew Gardens; with a specimen of the Heller collection determined by Earle and with a cotype specimen kindly sent to me by Dr. H. Sydow. It does not, however, conform to the description of this species as given by Gaillard, or the original description of Winter, in that the capitate hyphopodia are not often opposite, as they describe, and as Gaillard figures them, nor are the setae deeply bifid as he describes and figures. Since the original description was by Winter and the Brazilian specimen was published by Winter, and our specimen is clearly co-specific with the Brazilian specimen, it seems best to regard the present series as *M. bicornis.*

On Meibomia, the tips are either acute and simple, or bifid or toothed. Some collections are uniformly simple, others uniformly toothed, yet the species appears to be identical. The collections on *M. adscendens* and *M. axillaris* are rarely forked, while those on *M. supina* are rarely undivided. One collection on *M. axillaris,* No. *7838,* however showed a remarkable variant, with much and very irregularly forked apices. The form on Erythrina has few setae and these sometimes contorted at the tip. The specimens on Bradburya show the capitate hyphopodia somewhat more angular, with simple and unusally bent setae.

95a. M. BICORNIS VAR. CALOPOGONII var. nov.

On *Calopogonium orthocarpum* Urb.

Dos Bocas, below Utuado, July 8, '15, *8060*, Dec. 16, '13, *6035.*

Mayaguez, Oct. 31, '13, *3492*, Apr. 10, '13, *372.* Aguada, Nov. 22, '13, *5087.*

The form on Calopogonium shows perhaps greater differentiation than any of the other forms. The setae are more rigid, more uniformly fine toothed and the capitate hyphopodia are a trifle larger than on other hosts.

95b. M. BICORNIS VAR. GALACTIAE var. nov.

On *Galactia dubia* P. DC.

Rio Tanama, July 6, '15, *7856* (type).

The form on Galactia is well differentiated with large, capitate hyphopodia and usually with divided setae.

Meliola sp. indet. Mayaguez, May 1, '13, No. 1067 on a legume said by Percy Wilson to be "possibly a narrow leaved form of *Clitoria rubiginosa* Juss."

This collection consisting of a few leaves I have not named because of the scanty material. It is a 4-septate form with no mycelial setae, but with obtuse perithecial appendages which are curved, 27-51 x 7μ, Perithecia 125-172μ in diameter. Mycelium quite typical in the manner in which the threads anastomose. Capitate hyphopodia alternate, head cell nearly globular. Mucronate hyphopodia opposite or alternate, neck long, narrow. Spores 4-septate, 41 x 17μ, obtuse.

M. cookenana, Speg. Specimens on Lippia, Stachytarpheta and Lantana, bearing this name are in the New York Garden collections. The determination on Lantana is evidently erroneous. The other specimens have not been examined.

HOST LIST

Arranged by Families

Polypodiaceae	
Adiantum latifolium	M. pteridicola
Adiantum sp.	M. pteridicola
Schizaeaceae	
Aneimia adiantifolia	M. pteridicola
Aneimia sp.	M. pteridicola
Gramineae	M. panici
Andropogon bicornis	M. panici
Andropogon leucostachyus	M. panici
Paspalum schreberianum	M. panici
Paspalum glutinosum	M. panici
Panicum glutinosum	M. panici
Lasiacis swartziana	M. panici
Lasiacis compacta	M. panici
Lasiacis divaricata	M. panici
Ichnanthus pallens	M. panici
Oplismenus setarius	M. panici
Olyra latifolia	M .panici
Stenotaphrum secundatum	M. stenotaphri
Chloris petraea	M. panici

Six other species have been reported upon Graminae as follows: M. bambusae, M. herculeus, M. arundinis, M. amphitricha, M. furcata, M. substenospora.

Cyperaceae	
Mariscus jamaicensis	M. cyperi
Mariscus jamaicensis	M. circinans
Rhynchospora aurea	M. circinans
Cyperus sp.	M. cyperi
Scleria sp.	M. cyperi

Those previously reported upon the Cyperaceae are: M. circinans, M. intricata, M. amphitricha, M. argentina, M. uleana, M. cyperi-uleana, and M. cyperi-italica.

Palmae	
Macrodiscus lactiflorus	M. furcata
Acrista monticola	M. furcata
Thrinax ponceana	M. furcata
Thrinax praeceps	M. furcata
Coccothrinax alta	M. furcata

Roystonea borinquena	M. denticulata

Previously reported on the Palmae: M. iquitosensis, M. manaosensis, M. palmicola, M. amphitricha, M. contigua, M. furcata, M. hyalospora.

Araceae

Philodendron krebsii	M. philodendri
Dieffenbachia seguine	M. dieffenbachiae

Liliaceae

Smilax coriacea	M. smilacis

Three other species are reported on the Liliaceae, viz., M. hyalospora, M. subdentata, M. dracaenicola.

Piperaceae

Piper medium	M. tortuosa
Piper aduncum	M. glabroides, M. piperis, and M. gaillardiana
Piper peltatum	M. tortuosa
Piper umbellatum	M. tortuosa
Piper hispidum	M. contorta
Piper blattarum	M. paucipes

The species previously known upon Piper are: M. stenospora, M. asterinoides, M. patouillardi, M. pululahuensis, M. furcata, M. tortuosa, M. piperis, and M. glabra.

Myricaceae

Myrica cerifera	M. manca

Urticaceae

Pilea parietaria	M. earlii and M. triloba
Pilea nummularifolia	M. earlii
Pilea sp.	M. earlii

M. thomasiana has also been reported upon the Urticaceae.

Polygonaceae

Coccolobis pyrifolia	M. praetervisa
Coccolobis sentenisii	M. praetervisa
Coccolobis laurifolia	M. rectangularis
Coccolobis sps.	M. praetervisa

Magnoliaceae

Magnolia portoricensis	M. magnoliae

M. amphitricha and M. piptochaeta have previously been reported upon this family.

Anonaceae

Anona montana	M. longipoda

M. uvariae has been reported upon this family.

Lauraceae

Persea gratissima	M. perseae

Ocotea leucoxylon	M. ocoteae and M. ocoteicola
Nectandra patens	M. glabroides

The following species have heretofore been reported upon the Lauraceae: M. calva, M. ziz-zag, M. praetervisa, M. martiniana, M. penicillata, M. anomala, M. manca, M. amphitricha, M. acutiseta.

Rosaceae	
Rubus sp.	M. puiggarii
Leguminosae	
Inga laurina	M. toruloidea
Mimosa ceratonia	M. bicornis
Lonchocarpus glaucifolius	M. bicornis
Cassia quinquadrangulata	M. toruloidea
Clitoria rubiginosa (?)	M. sp. ind.
Meibomia axillaris	M. bicornis
Meibomia adscendens	M. bicornis
Meibomia supina	M. bicornis
Dalbergia monetaria	M. bicornis
Dalbergia sps.	M. bicornis
Andira jamaicensis	M. andirae
Bradburya virginiana	M. bicornis
Erythrina micropteryx	M. bicornis
Teramnus uncinatus	M. bicornis
Rudolphia volubilis	M. rudolphiae
Calopogonium orthocarpum	M. bicornis var. calopogonii
Galactia dubia	M. bicornis var. galactiae
Dolicholus reticulatus	M. bicornis
Chamaecrista granulata	M. chamaecristicola
Chamaecrista "glandulosa"	M. chamaecristae

The following species of Meliola have been reported upon the Leguminosae: M. desmodii, M. ludibunda, M. malacotricha, M. bicornis, M. juruana, M. chamaecristae, M. denticulata, M. harioti, M. pellucida, M. zollingeri, M. andirae, M. gleditschiae, M. musae, M. pazschkeana, M. pseudoanastomosans, M. subtorulosa, M. tamarindi.

Rutaceae	
Pilocarpus racemosus	M. pilocarpi
Amyris elemifera	M. monensis

In addition to the species mentioned above, the following have been reported upon the Rutuceae: M. obesa, M. evodiae, M. obesula, M. tenella, M. microtheca, M. butleri, M. amphitricha, M. patens, M. ludibunda.

Simarubaceae	
Simaruba tulae	M. glabroides
Meliaceae	
Guarea trichilioides	M. guareae and M. guareicola

Other species described upon the Meliaceae are: M. macalpini, M. sandarici, M. opposita, M. parvula.

Malpighiaceae	
Banisteria laurifolia	M. rectangularis
Byrsonima lucida	M. byrsonimae

Two other species have been reported upon the Malpighiaceae, namely, M. stuhlmanniana and M. crenata.

Euphorbiaceae	
Drypetes sps.	M. glabra
Acalypha bisetosa	M. arecibensis
Jatropha hernandifolia	M. jatrophae
Gymnanthes lucida	M. gymnanthicola

Other forms reported upon the Euphorbiaceae are: M. malacotricha, M. patella, M. verrucosa, M. acalyphae, M. manihoticola, M. cornucaprae.

Anacardiaceae	
Mangifera indica	M. mangiferae
Spondias mombin	M. comocladiae
Comocladia glabra	M. comocladiae

The following species have been reported upon the Anacardiaceae: M. rhois, M. guercinopsis, M. malacotricha, M. lanigera, M. irradians, M. mangiferae, M. polytricha, M. anacardii, M. geniculata, M. coronata, M. dracontomeli.

Aquifoliaceae	
Ilex nitida	M. maricaensis

Other species reported upon the Aquefoliaceae are: M. ilicis, M. lagersheimii, M. cornuta, M. yerbae.

Celastraceae	
Crossopetalum pallens	M. compacta

Species previously reported upon the Celastraceae are: M. falcatiseta and M. gymnosporiae.

Staphylaceae	
Turpinia panniculata	M. guignardi
Sapindaceae	
Serjania polyphylla	M. serjaniae
Paullinia pinnata	M. hessii and M. paulliniae
Thouinia striata	M. thouiniae

Allophylus crassinervis	M. thouiniae
Cupania americana	M. cupaniae and M. praetervisa
Cupania sps.	M. cupaniae
Hypelate trifoliate	M. glabra

Following is a list of the species previously reported upon the Sapindaceae: M. wrightii, M. parenchymata, M. sapindacearum, M. crucifera, M. ambigua, M. thouiniae, M. araneosa, M. bombphlandi.

Rhamnaceae

Krugiodendron ferreum	M. thouineae
Gouania lupuloides	M. tenuissima

Previously reported upon the Rhamnaceae, M. scutiae.

Vitaceae

Cissus sicyoides	M. merrillii

One other species is reported upon the Vitaceae, namely, M. paraensis.

Tiliaceae

Triumfetta semitriloba	M. triumfettae

Malvaceae

Sida urens	M. molleriana
Hibiscus tiliaceus	M. triumfettae

Two species have been reported upon the Malvaceae, viz., M. molleriana and M. sidae.

Ochnaceae	
Sauvagesia erecta	M. glabroides
Guttiferae	
Calophyllum calaba	M. calophylli
Mammea americana	M. paulliniae
Clusia minor	M. clusiae
Winteranaceae	
Winterana canella	M. thouiniae
Flacourtiaceae	
Casearia ramiflora	M. paulliniae
Casearia sylvestris	M. paulliniae
Casearia arborea	M. paulliniae
Casearia aculeata	M. paulliniae
Casearia sp.	M. paulliniae
Cambretaceae	
Laguncularia racemosa	M. laguncularia and M. nigra

Only one species had heretofore been reported upon this family.

Myrtaceae

Amomis caryophyllata	M. amomicola
Psidium guajava	M. psidii

Myrcia deflexa	M. helleri
Myrcia splendens	M. helleri
Eugenia stahlii	M. helleri
Eugenia monticola	M. helleri

The following have been recorded upon the Myrtaceae: M. psidii, M. helleri, M. puchella, M. arborescens, M. laxa, M. densa, M. horrida, M. cladotricha, M. clavispora, M. valdivivensis.

Melastomataceae	
Miconia laevigata	M. melastomacearum
Miconia racemosa	M. melastomacearum
Miconia sentenisii	M. miconieicola
Miconia prasina	M. miconiae
Clidemia hirta	M. melastomacearum
Clidemia strigillosa	M. melastomacearum

Species other than the above which have been reported upon the Melastomataceae are: M. heudeloti, M. weigettii, M. memecyli, M. affinis.

Araliaceae	
Dendropanax arboreum	M. didymopanicis
Dendropanax laurifolium	M. didymopanicis

Other species on the Araliaceae are: M. araliae, M. dichotoma, M. kusanoi, M. heterosetae, M. pectinata, M. leplidae.

Myrsinaceae	
Ardisia guadalupensis	M. myrsiniacearum
Parathesis serrulata	M. parathesicola

The following species have been reported upon the Myrsinaceae: M. cladotricha, M. quercinopsis, M. delicatula, M. armata, M. groteana, M. perigrina, M. maesae.

Sapotaceae	
Lucuma multiflora	M. lucumae
Dipholis salicifolia	M. dipholidis
Chrysophyllum sp.	M. ocoteicola

M. brasiliensis is the species previously reported on the Sapotaceae.

Oleaceae	M. mayepeae
Mayepea domingensis	M. mayepeicola

M. jasminicola has been reported on this family.

Apocynaceae	
Plumiera krugii	M. tabernaemontanae
Tabernaemontana oppositifolia	M. tabernaemontanae
Rauwolfia nitida	M. tabernaemontanae
Forsteronia corymbosa	M. tabernaemontanae var. forsteroniae

Other species previously recorded upon the Apocynaceae are: M. levipoda, M. simillima, M. intermedia, M. willoughbyae, M. clavitispora, M. compositarum, M. membranacea, M. laevigata.

Convolvulaceae

Ipomoea cathartica	M. clavulata, M. ipomoeae, and M. quadrispina
Ipomoea tiliacea	M. clavulata and M. ipomoeae
Ipomoea batatas	M. clavulata
Ipomoea sps.	M. clavulata and M. ipomoeae

Other species recorded for this family are: M. decidua, M. ambigua, M. melacotricha, M. ipomoeaephile, M. merremiae, M. francevilleana, M. caymanensis, M. hewittiae.

Borraginaceae

Cordia nitida	M. longipoda
Cordia sps.	M. longipoda
Tournefortia hirsutissima	M. longipoda
Varronia sps.	M. molleriana

In addition to the above, M. usteriana has been reported upon the Borraginaceae.

Verbenaceae

Stachytarpheta cayennensis	M. glabroides
Lantana odorata	M. ambigua
Lantana camara	M. ambigua
Lantana sps.	M. ambigua
Lantana sps.	M. cookeana (?)
Avicennia nitida	M. sepulta

Other species recorded on the Verbenaceae are: M. durantae, M. sakawensis, M. callicarpae, M. clerodendricola, M. amphitricha, M. lippiae, M. coronata, M. vitis, M. lantanae.

Labiatae

Hyptis lantanifolia	M. hyptidicola
Hyptis capitata	M. hyptidicola
Hyptis pectinata	M. hyptidicola
Hyptis sp.	M. hyptidicola

Other species recorded on the Labiateae are: M. anastomosans, M. inermis, M. pelliculosa, M. hyptidis.

Solanaceae

Solanum rugosum	M. glabroides
Solanum persicifolium	M. glabroides
Solanum jamaicense	M. solani
Capsicum baccatum	M. capsicola
Cestrum laurifolium	M. gesneriae
Cestrum macrophyllum	M. gesneriae

Other species on the Solanaceae are: M. winteri, M. plebeja, M. glabra, M. solanicola Gaill., M. acervata, M. solanicola P. Henn.

Bignoniaceae

Macrodiscus lactiflorus	M. furcata
Tecoma pentaphylla	M. tecomae and M. bidentata
Tecoma sps.	M. tecomae
Tabebuia haemantha	M. bidentata
Schlegelia sps.	M. glabroides var. schlegeliae

Species previously recorded upon the Bignoniaceae are: M. arachnoidea, M. bidentata, M. furcata, M. harioti, M. lanceolato-setosa.

Gesneriaceae

Gesneria albiflora	M. gesneriae

Acanthaceae

Hygrophila brasiliensis	M. irregularis

Rubiaceae

Gonzalagunia spicata	M. psychotriae
Randia aculeata	M. psychotriae
Erithalis fruticosa	M. psychotriae
Chiococca alba	M. chiococcae and M. psychotriae
Guettarda ovalifolia	M. psychotriae
Palicourea crocea	M. mayaguesiana
Palicourea riparia	M. mayaguesiana
Palicourea domingensis	M. mayaguesiana and M. glabra var. psychotriae
Palicourea sps.	M. mayaguesiana and M. glabra var. psychotriae
Borreria laevis	M. psychotriae
Borreria ocimoides	M. psychotriae
Coccocypselum repens	M. glabra var. psychotriae
Psychotria pubescens	M. glabra var. psychotriae
Psychotria grandis	M. glabra var. psychotriae
Psychotria bertiana	M. glabra var. psychotriae
Psychotria sp.	M. glabra var. psychotriae
Rubiaceae indet.	M. psychotriae

Other species on the Rubiaceae are: M. intermedia, M. sandicensis, M. longiseta, M. falcata, M. manca, M. rubicola, M. cryptocarpa, M. glabra, M. palawanensis, M. pencilliformis, M. asterinoides, M. mitchelliae.

Cucurbitaceae

Cayaponia (?)	M. cucurbitacearum

Three species, none of them with forked setae, have been noted upon the Cucurbitaceae, namely: M. triloba, M. malacotricha, M. aciculosa.

Compositae	
Pseudelephantopus spicatus	M. cyclopoda
Eupatorium odoratum	M. compositarum
Eupatorium portoricense	M. compositarum var. portoricensis

Species previously reported upon the Compositae are: M. sororcula, M. spegazziniana, M. mikaniae, M. compositarum, M. inermia, M. amphitricha, M. tortuosa.

Host unknown	M. bidentata
Host unknown	M. amphitricha
Host unknown	M. tuberculata
Host unknown	M. paulliniae
Host unknown	M. aibonitensis
Host unknown	M. sp. ind.

EXPLANATION OF PLATES

All plates are from photo-micrographs made by Mr. A. G. Eldredge. They were reduced 28% in reproduction. The abbreviations l.p. and h.p. indicate low power and high power with a magnification of approximately 75 and 355 diameters respectively. Scales showing the magnification are given in plate V; the smallest divisions are 10μ wide.

EXPLANATION OF PLATE I

Fig. 1. M. puigiarii: portion of perithecium and larvaeform appendages. h.p. No. 8270.

Fig. 2. M. manca: mycelium, capitate hyphopodia, a germinating spore. h.p. No. 1292 N. A. F.

Fig. 3. M. guignardi: general type of colony, mycelium and capitate hyphopodia. No. 8922. l.p.

Fig. 4. M. glabra: showing type of mycelium and hyphopodia. l.p. Rabenhorst, Fung. Europ. No. 3849.

Fig. 5. M. sepulta: type of colony and mycelium. l.p. Heller's collection. No. 6416.

Fig. 6. M. irregularis: spores showing irregularity in size of cells. h.p. No. 9283 (type).

Fig. 7. M. solani: mycelium showing opposite hyphopodia. h.p. No. 5750 (type).

Fig. 8. M. hyptidicola: a showing perithecia, crooked mycelium, and oval hyphopodia. l.p.
b mycelium and hyphopodia in greater detail. h.p. No. 8526.

Fig. 9. M. cyclopoda: general view showing colony, rough perithecia, and character of mycelium and hyphopodia. l.p. No. 7733 (type).

Fig. 10. M. perseae: irregular, crooked mycelium, mucronate hyphopodia and angular capitate hyphopodia. h.p. No. 8212 (type).

Fig. 11. M. longipoda: mycelium, capitate and mucronate hyphopodia, ascospores and a young perithecium. h.p. No. 9329.

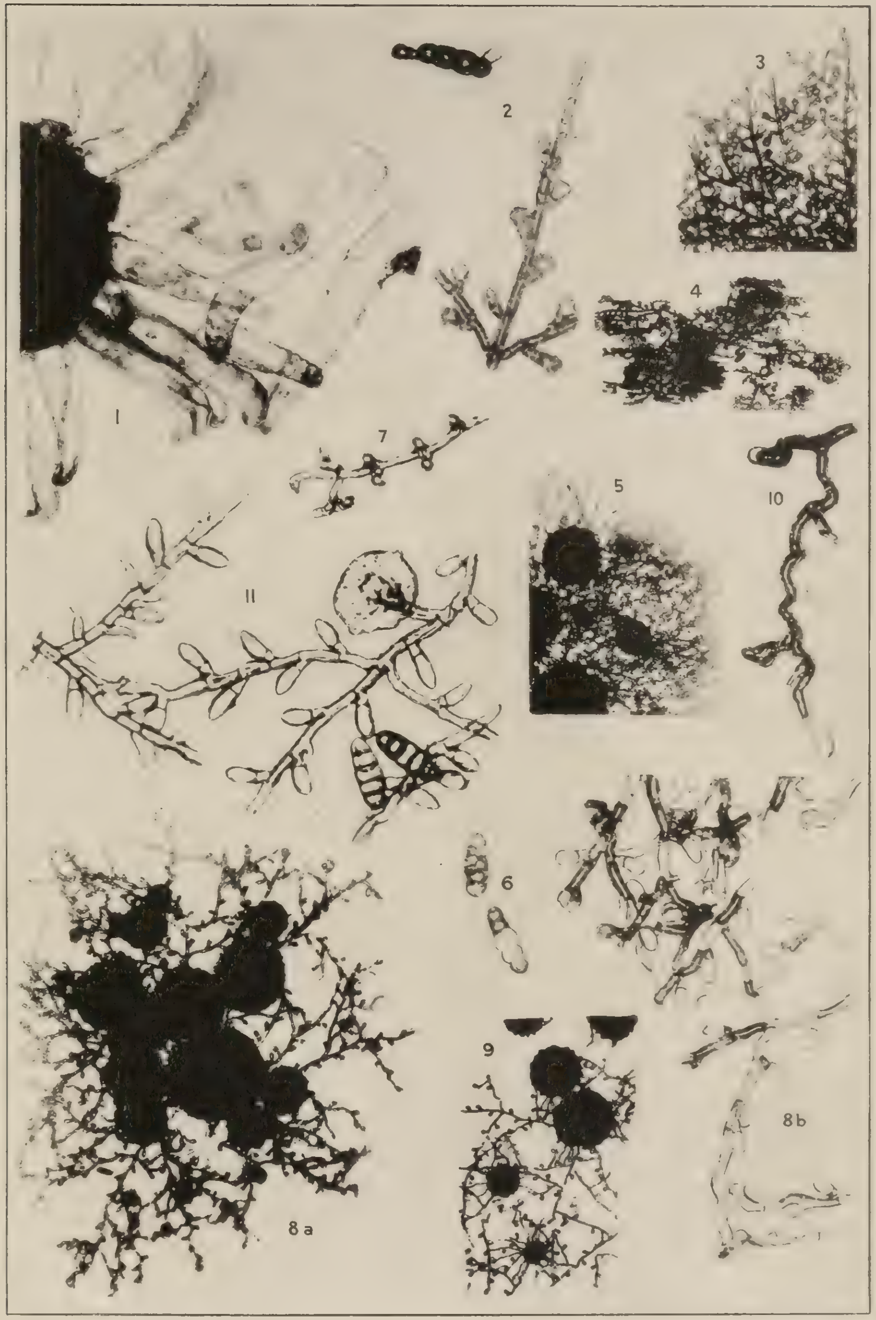
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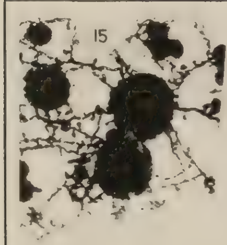
PLATE II

EXPLANATION OF PLATE II

Fig. 12. M. melastomacearum: perithecia, mycelium and hyphopodia. l.p. No. 8956.
Fig. 13. M. glabroides: germinating spore with hyphopodia. h.p. No. 3371 (type).
Fig. 14. M. triloba: spore and young mycelium with typically lobed capitate hyphopodia. h.p. No. 1038.
Fig. 15. M. compositarum: colony showing perithecium with larvaeform appendage, mycelium and hyphopodia. l.p. Heller, No. 6185 (co-type).
Fig. 16. M. compositarum var. portoricensis: showing mycelium and capitate hyphopodia. h.p. No. 7723.
Fig. 17. M. calophylli: irregular mycelium and head cells. h.p. No. 7059 (type).
Fig. 18. M. arecibensis: mycelium and crowded hyphopodia. h.p. No. 365a (type).
Fig. 19. M. miconieicola: loose, scant mycelium with distant hyphopodia. l.p. No. 8639 (type).
Fig. 20. M. parathesicola: capitate hyphopodia very crowded. h.p. No. 7286.
Fig. 21. M. toruloidea: perithecia, young and old, mycelium and hyphopodia. l.p. No. 8394 (type). A few setae are visible on the perithecia.
Fig. 22. M. comocladiae: colony showing character of mycelium and hyphopodia. l.p. No. 9015 (type).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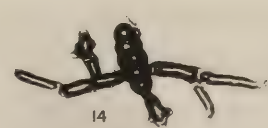
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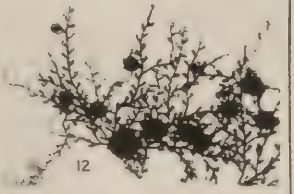
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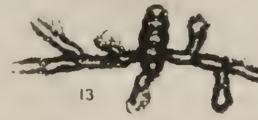
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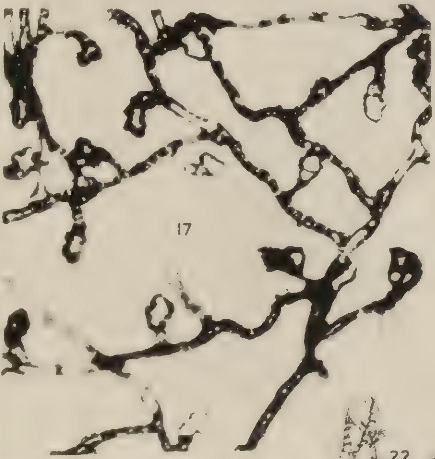
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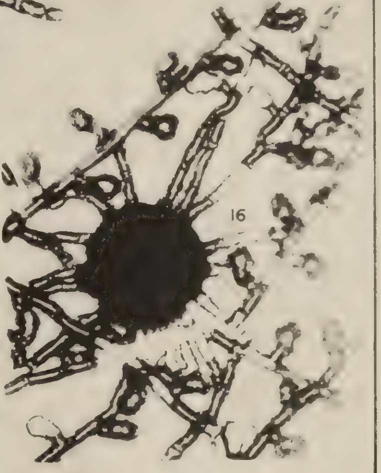
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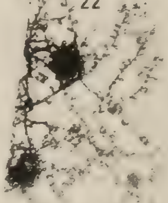
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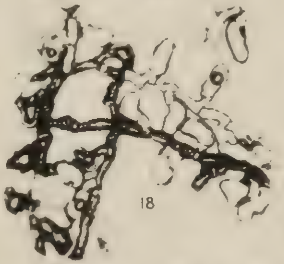
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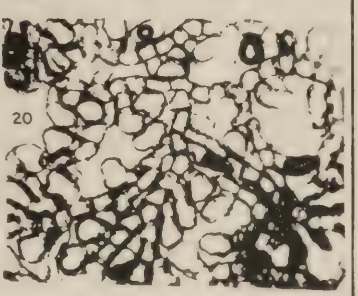
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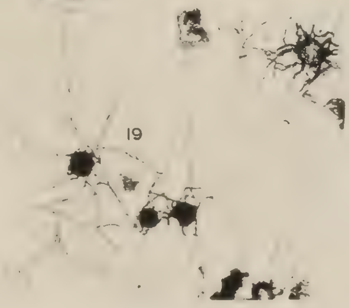
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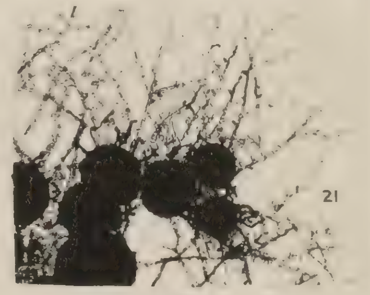
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PLATE III

EXPLANATION OF PLATE III

Fig. 23. M. tortuosa: perithecium and appendages, with tortuose tips. l.p. No. 4714.

Fig. 24. M. chamaecristicola: showing thin setae on perithecia. l.p. No, 6113 (type).

Fig. 25. M. rectangularis: showing right-angle type of branching. h.p. No. 7292 (type).

Fig. 26. M. chiococcae: mycelium, angular hyphopodia, young perithecium with radiating mycelium. h.p. No. 7743 (type).

Fig. 27. M. pteridicola: showing parallel coursing of mycelium. l.p. No. 7814 (type).

Fig. 28. M. cupaniae: showing perithecial setae. l.p. No. 9143 (type).

Fig. 29. M. miconiae: general habit of mycelium. l.p. No. 9366.

Fog. 30. M. contorta: perithecia and crooked perithecial setae. l.p. No. 8225 (type).

Fig. 31. M. mayaguesiana: ascospore, mycelium and capitate hyphopodia. h.p. No. 7157 (type).

Fig. 32. M. clavulata: swollen setal tips. h.p. No. 7837.

Fig. 33. M. praetervisa: spore and mycelium showing characteristic conic capitate hyphopodia. h.p. No. 5653a.

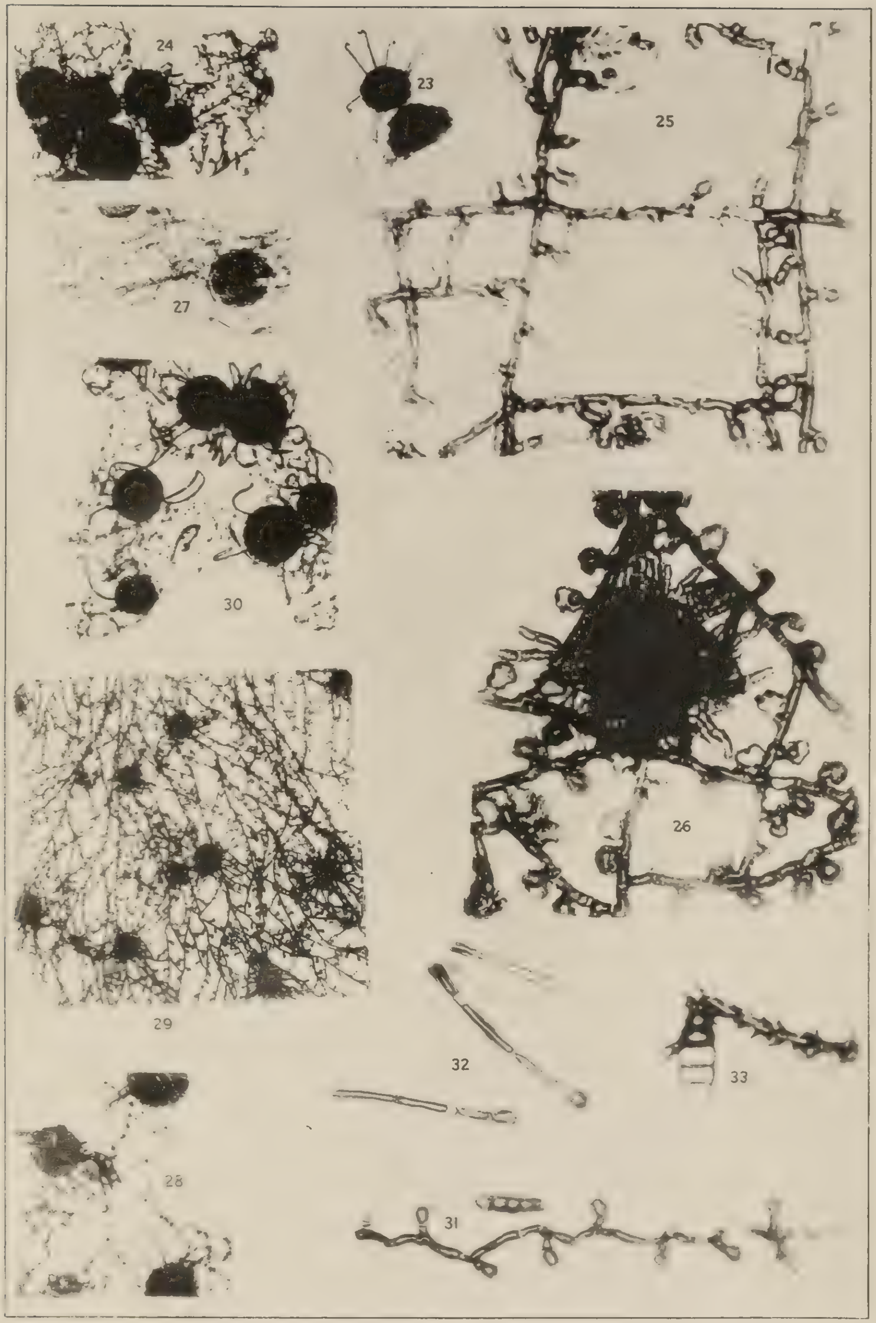
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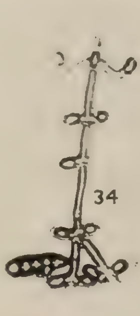
PLATE IV

EXPLANATION OF PLATE IV

Fig. 34. M. andirae: a spore, mycelium showing characteristic opposite capitate hyphopodia. h.p. Earle (co-type). No. 6448.
Fig. 35. M. monensis: showing typical hyphopodia. h.p. No. 6158 (type).
Fig. 36. M. thouiniae: capitate and mucronate hyphopodia. h.p. Heller, No. 6435 (type).
Fig. 37. M. amomicola: typical opposite hyphopodia. h.p. No. 7054 (type).
Fig. 38. M. stenotaphri: crooked mycelium, long setae. l.p. No. 8023.
Fig. 39. M. capsicola: showing irregular hyphopodia. l.p. No. 8019 (type).
Fig. 40. M. paucipes: distant hyphopodia and long, black setae. l.p. No. 7463 (type).
Fig. 41. M. rudolphiae: mycelium, capitate hyphopodia and a spore. h.p. No. 8698.
Fig. 42. M. serjaniae: alternate capitate and opposite mucronate hyphopodia. h.p. No. 425 (type).
Fig. 43. M. ocoteicola: characteristic capitate hyphopodia. h.p. No. 7560 (type).
Fig. 44. M. polytricha K. & C.: edge of colony showing habit. "No. 1262 on Cunonia capensis. Grahamstown, Cape, ex Kalchbrenner." h.p. (type).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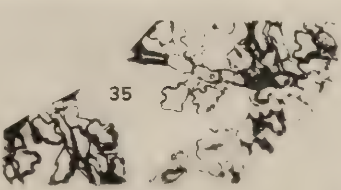
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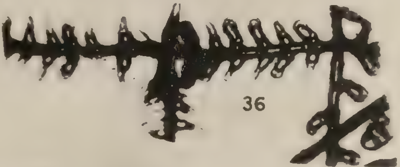
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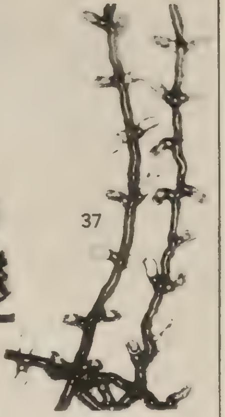
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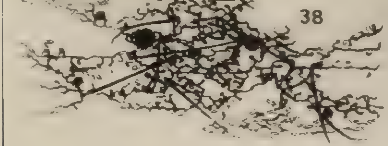
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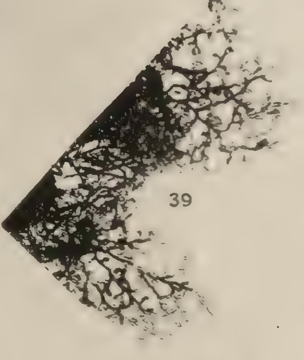
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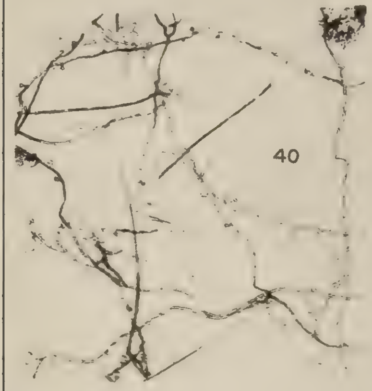
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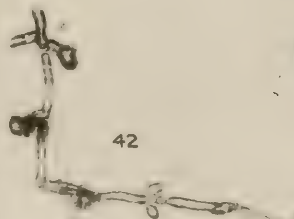
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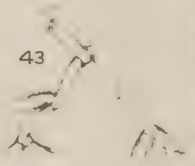
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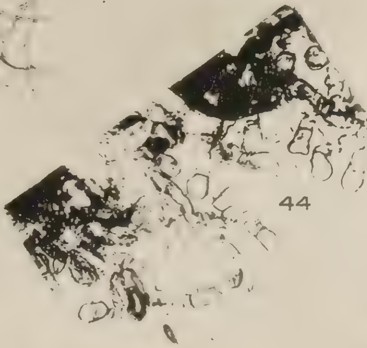
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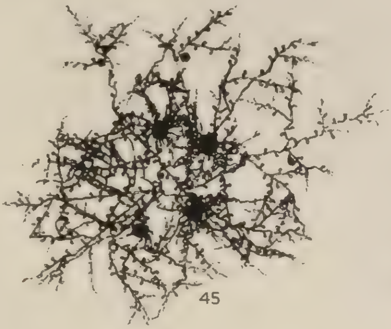
PLATE V

EXPLANATION OF PLATE V

Fig. 45. M. earlii: colony showing mycelial character. l.p. No. 7685 (type).
Fig. 46. M. mayepeae: general character of colony. l.p. No. 7468 (type).
Fig. 47. M. lucumae: mycelium and capitate hyphopodia, young perithecium. l.p. No. 8164 (type).
Fig. 48. M. tecomae: showing curved tips of setae. h.p. No. 9332 (type).
Fig. 49. M. ipomoeae: colony, mycelium, opposite hyphopodia, long setae, perithecia. l.p. No. 6563.
Fig. 50. M. magnoliae: setal tip showing forking. h.p. No. 4738 (type).
Fig. 51. M. cucurbitacearum: showing forking of setal tips. h.p. No. 8732 (type).
Fig. 52. M. hessii: a setum showing character of forking, a bit of mycelium. l.p. No. 9367 (type).
Fig. 53. M. quadrispina: general type of colony. l.p. No. 8163.
Fig. 54. M. philodendri: primary branching of setal tip. h.p. No. 4346.
Fig. 55. M. gaillardiana: crested setum. h.p. No. 7794 (type).
Fig. 56. M. dieffenbachiae: setal tip. h.p. No. 8148 (type).
Fig. 57. M. bicornis, "authentic specimen" from Kew gardens determined by Winter: spore, mycelium and capitate and mucronate hyphopodia. h.p.
Fig. h.p. millimeter scale ruled to 1/10 mm. high power.
Fig. l.p. ditto with low power magnification.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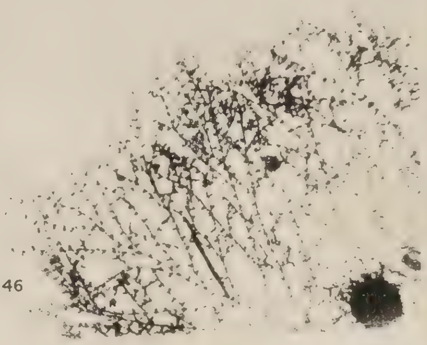
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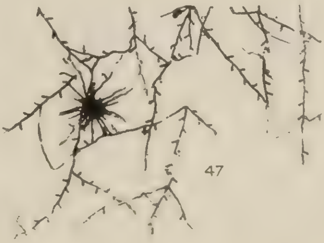
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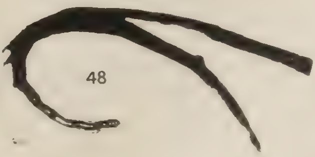
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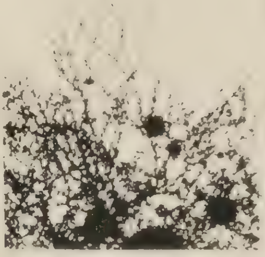
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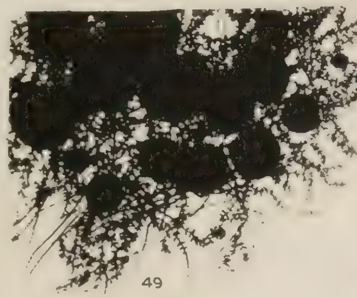
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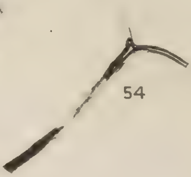
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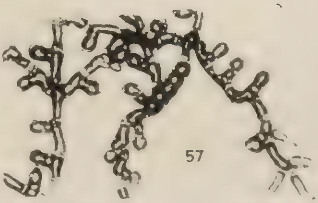
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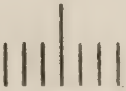
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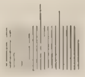
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ALPHABETICAL LIST OF SPECIES

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